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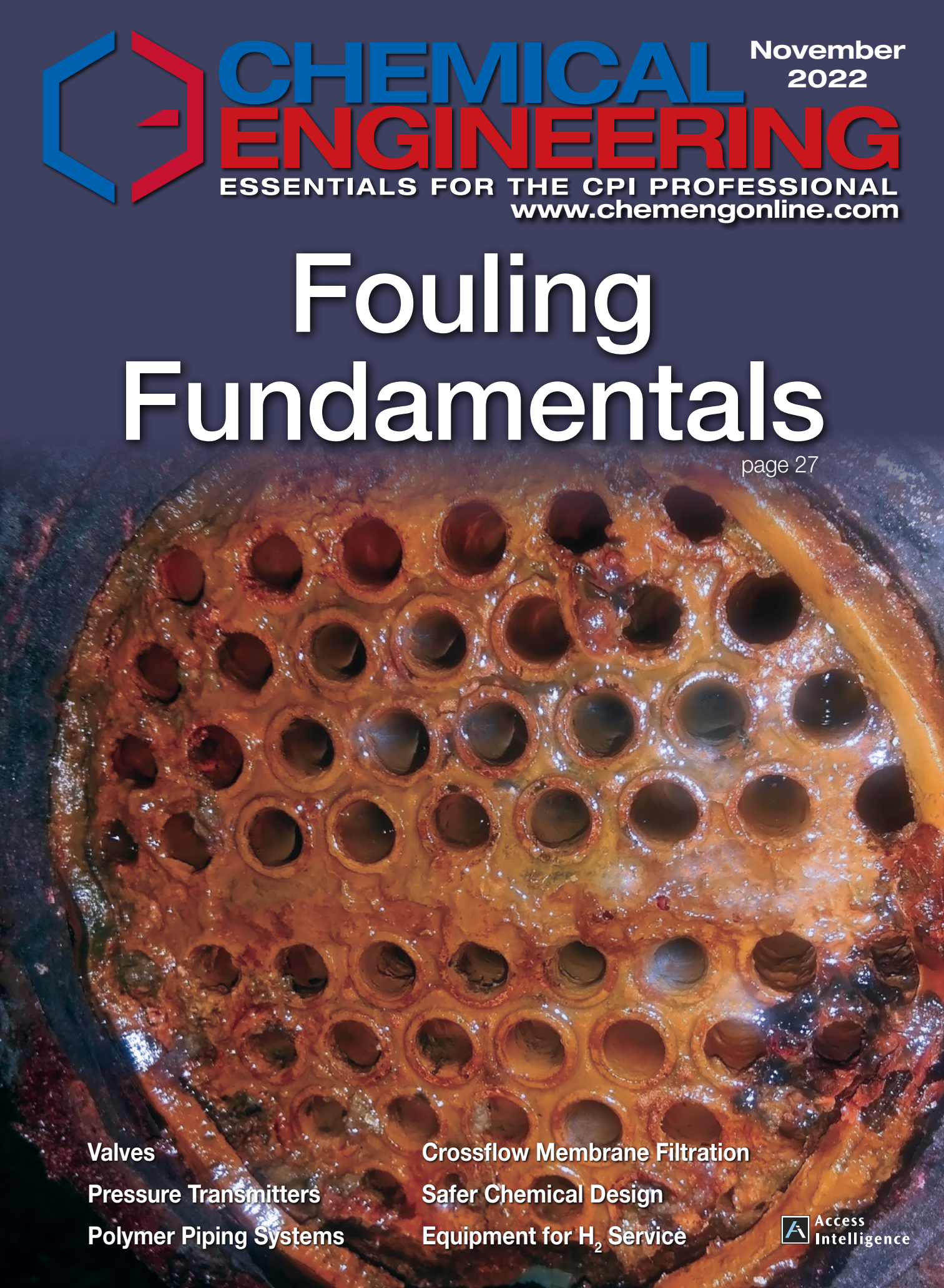

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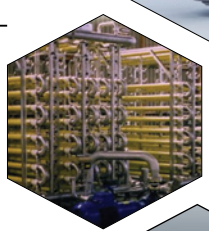

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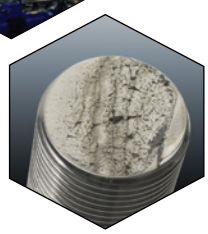

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VERIFIED AUDIT

Editor's Page

Planning practically for hydrogen

The U.S. Energy Information Admin. (Washington, D.C.; www.eia.gov) projects a nearly 50% increase in global energy use by 2050. Coinciding with this demand explosion, ambitious sustainability targets are necessitating a widespread transition to more climate-friendly technologies. Hydrogen is poised as a solution to provide energy relief on both fronts. The prominence of hydrogen in industrial decarbonization was highlighted at the HydrogenNext conference, presented by *Chemical Engineering* and *POWER* (www.hydrogenextevent.com).

Workforce and infrastructure

"There's no pathway to net zero without low-carbon fuels like hydrogen and ammonia," emphasized event keynote speaker Robert Chapman of the Electric Power Research Institute (EPRI; Palo Alto, Calif.; www.epri.com). EPRI estimates that the hydrogen economy will require a workforce of 30 million jobs by 2050. In another keynote presentation, Thomas Smith of Caterpillar Inc. (Deerfield, Ill.; www.caterpillar.com), posited that the energy transition — especially hydrogen-based solutions — will require complementary skillsets to the existing industrial workforce, such as mechanics and maintenance technicians. Similar to leveraging analogous labor skillsets, a major benefit of hydrogen-based decarbonization is the ability to repurpose existing infrastructure. "One of the greatest things about hydrogen is that you can re-use existing assets like boilers, engines and combustion turbines, keeping infrastructure in use rather than forcing it to retire," said Patrick Daou of Sargent & Lundy, LLC (Chicago, Ill.; www.sargentlundy.com) during a panel discussion on hydrogen usage, market and demand. Specifically, explains fellow panelist Jeff Chase of SoCal Gas Co. (Los Angeles, Calif.; www.socalgas.com), natural-gas distribution systems are a very advantageous place to leverage existing assets.

Overcoming hurdles with research and demonstration

There are many technical hurdles to overcome before the hydrogen economy is fully realized at scale, including storage and transport, but industry experts remain optimistic. "At this point in the evolution of the hydrogen economy, demonstration projects at any scale are extremely helpful," said Scott Conway of Caterpillar Electric Power. Several such demonstration projects were detailed at HydrogeNext, including the world's largest hydrogen fuel-blending project at the McDonough-Atkinson power plant in Smyrna, Ga. Panelists discussing this industry-leading project reiterated that a crucial key to success was fostering a deep relationship between plant management teams and equipment manufacturers.

Cost concerns

A major concern for operating companies investigating renewable hydrogen projects is cost. Although the current costs for renewable hydrogen may indeed be higher than other established platforms, there is optimism around the lowered cost of production (especially via electrolysis), as well as the incentives of the recent Inflation Reduction Act in the U.S. "Hydrogen is the only thing that makes sense when you look at the scenario of the next 20–30 years," said Hari Gopalakrishna of Mitsubishi Power Ltd. (Lake Mary, Fla.; www.power.mhi.com). When considering costs, he encouraged examining the total system cost for hydrogen use, rather than the commodity cost of hydrogen itself, to get a better view of the hydrogen economy.

HydrogeNext will take place again August 14–17, 2023, in Savannah, Ga., where the conversations about the latest advances will continue. ■

Mary Page Bailey, Senior Associate Editor

This batch reactor saves time, energy, space and more

Batch reactors are widely used throughout the chemical process industries (CPI), and the basic design has not radically changed for many decades. Nevertheless, precise temperature control of batch processes continues to be a common problem.

Now, a new design of a complete batch-reactor system has been developed by Process Technology Strategic Consultancy Ltd. (PTSC; Alloa, Scotland; www.ptscltd.co.uk) that can reduce batch processing times by 75% while saving 35% in energy consumption, according to the company.

The key feature of the so-called PI QFlux reactor (photo) is a patented heated-baffle design, explains process engineer Tom McKenna. The baffles contain internal channels through which a heat-transfer fluid can circulate to dramatically improve the temperature control. Because the baffles are affixed to the reactor vessel, they provide "exceptional structural integrity," compared to alternative methods, such as the immersion of heating/cooling coils, plates or spiral-wound piping systems. This design also has the advantage of increased surface area, which is also suitable for sanitization.

PTSC has been working with the University of Aberdeen and Glasgow Caledonian University, together with a number of industrial partners, to develop a prototype. Kobelco Eco-Solutions Co. Ltd. (Kobe; Japan) and Aggreko plc (Glasgow; Scotland) worked with PTSC to create a purpose-built test facility in Harima, Japan. Recently, large-scale tests (1,000-L batch size) were performed involving a back-to-back comparison of heating rates of the PI QFlux against a conventional glass-lined reactor, where the vessel contents were heated between two predetermined temperatures, for different fluids, using the same site services. In these tests, it was demonstrated that the PI QFlux reactor is four times faster than other batch reactors operating under the same conditions while using up to 50% less energy than traditional technologies.

The new batch reactor can easily be retrofitted into existing plants. PTSC is able to work with early adopters of the technology from now on, with first availability of PI QFlux reactor systems in 2Q of 2023, says McKenna.

Engineering duckweed to increase oil production

Scientists at the U.S. Dept. of Energy's Brookhaven National Laboratory (BNL; Upton, N.Y.; www.bnl.gov) and collaborators at Cold Spring Harbor Laboratory (CSHL; Laurel Hollow, N.Y.; www.cshl.edu) have genetically engineered a strain of duckweed (*Lemna japonica*) to produce high yields of oil. As described in a recent issue of *Plant Biotechnology Journal*, the engineered *L. japonica* accumulates oil at close to 10% of its dry-weight biomass — a 100-fold increase over such plants growing in the wild. Yields were more than seven times higher than soybeans, today's largest source of biodiesel in the U.S.

"Duckweed grows fast," says BNL biochemist John Shanklin, who led the team. "It has only tiny stems and roots, so most of its biomass is in leaf-like fronds that grow on the surface of ponds worldwide he says. "Growing and harvesting this engineered duckweed in batches and extracting its oil could be an efficient pathway to renewable and sustainable oil production."

One of the oil-production genes identified by the BNL researchers pushes the production of fatty acids (FAs). Another assembles those FAs into triacylglycerols (TAG) — combinations of three FAs that link up to form hydrocarbons. A third gene produces a protein that coats oil droplets in plant tissues, protecting them from degradation. Overexpression of each gene modification alone did not significantly increase FA levels in *L. japonica* fronds. But plants engineered with all three modifications accumulated up to 16% of their dry weight as FAs and 8.7% as oil when results were averaged across several different transgenic lines.

In addition to further genetic studies, "we are working on how to scale up production from laboratory to industrial levels," Shanklin says. This effort includes designing large-scale culture vessels, optimizing growth conditions and developing efficient extraction methods.

Edited by:
Gerald Ondrey

CATALYSTS BY AM

In late September, BASF SE (Ludwigshafen, Germany; www.basf) introduced X3D, a new additive-manufacturing (AM; 3D printing) technology for shaping catalysts. Catalysts produced with this technology feature an open structure, resulting in a reduction of the pressure drop across the reactor and a high surface area, significantly improving the catalysts' performance, the company says. Catalysts made with X3D are said to be mechanically robust and proven in commercial-plant operation externally and for several years in BASF.

The company's sulfuric-acid catalysts O4-111 X3D and O4-115 X3D are the first catalysts produced with the new technology and are used in industrial plants.

BASF has capabilities to supply commercial quantities, and can apply the technology to a wide variety of existing catalytic materials, including base- or precious-metal catalysts, as well as carrier materials.

HYDROGENATION

Last month, BASF added two products to its selective-hydrogenation catalyst E 15x series. The new sulfur-resistant E 15x S catalyst family aims at facilitating the processing of contaminated feedstocks, enabling reliable process operation and thereby increasing the flexibility of producers to use low-quality feedstocks containing higher amounts of impurities. E 153 S ECU 1/8 in. is now installed in a world scale PyGas first-stage unit, proving its outstanding activity and outperform-

(Continues on p. 6)

ing the competitor incumbent catalyst, BASF says.

Also introduced is a new low-density carrier, serving as a platform for selective hydrogenation applications. The new E 15x L catalyst family is currently the company's most cost-efficient solution for hydrogenation units. E 15x L minimizes the amount of precious metal needed for a hydrogenation catalyst, without compromising catalyst activity. Dedicated carrier design and precious metal coating techniques enable a significant hydrogenation activity boost by high precious-metal dispersion. Detailed pilot studies proved reliable operation and significantly outperformed alternative low-density solutions in a direct comparison, the company says.

FOOD-GRADE LUBES

Last month, Renewable Lubricants, Inc. (Hartville, Ohio; www.renewable-lube.com) introduced what is claimed to be industry's first food-grade hydraulic fluids. With oxidation performance comparable to full synthetics, Bio-Food Grade hydraulic fluids are multifunctional, biosynthetic lubricants that contain ingredients that are classified as Generally Regarded as Safe (GRAS), making them suitable for applications with incidental food contact in and around food-processing equipment areas. They may be used on food-processing equipment as a protective anti-rust film, as a release agent on gaskets or seals of tank closures, and as a lubricant for machine parts and equipment in locations in which there is a potential exposure of the lubricated part to food. They can also be used in environmentally sensitive areas, such as agriculture, marine envi-

(Continues on p. 7)

A process for making improved composite insulation material

Hollow silica particles (HSPs) are materials of interest for thermal insulation applications because of their very low thermal conductivity, but the particles pose health hazards and the powder is impractical to use, so scientists have been trying to incorporate HSPs into polymer matrices to create highly insulative composites. Thus far, the efforts have resulted in composites with thermal conductivities that are higher than those of HSPs alone, thus compromising the purpose of the combination.

Now, however, researchers at the U.S. Department of Energy's Oak Ridge National Laboratory (ORNL; Oak Ridge, Tenn.; www.ornl.gov) have developed a process for making HSP-based thermal insulation composites with thermal conductivities similar or lower than HSPs alone, along with high moisture stability. The process could make HSP-based thermal insulation practical for applications such as refrigeration, heat exchange, thermal energy storage, cryogenic storage, combined heat and power, and others.

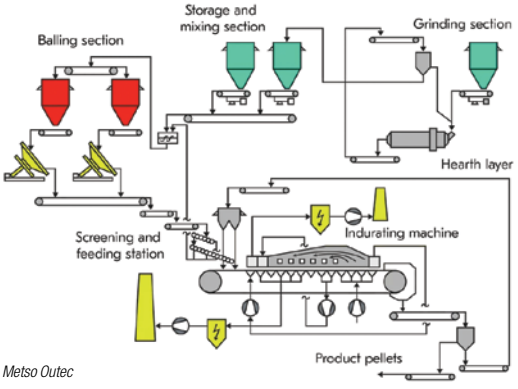
The composite is made by mixing HSPs with cellulose fibers (CF) and carbon black (CB) in water, then pouring the mixture into molds and removing water via a freeze-drying technique. A silane coating is then applied to impart hydrophobicity.

From electron microscopy and other analyses, the researchers surmise that the lowered thermal conductivity may result from both the increased air volume and increased interfacial contact resistance. This interfacial contact resistance results from the higher number of heterogenous interfaces (interfaces between HSPs and CF, between HSPs and CB, and between CF and CB) in the composite, the ORNL researchers say, in contrast to the HSPs alone, which have only one type of interface.

The ORNL research team says their work addresses the issues associated with using HSPs as a thermal insulation material, without compromising their insulative properties.

Another step towards 'green' steel

Last month, Metso Outotec Corp. (Helsinki, Finland; www.mogroup.com) introduced NextGen Pelletizing — a visionary concept for the next generation of iron-ore pelletizing plants that strive to be carbon neutral and autonomous. According to the company, the combination of innovations — many of which have already been implemented in part — can lead to: further energy reductions of 5 to 10%; CO_2 reductions of 80 to 90%; production and availability increase of 10 to 15%; as well as improved product homogeneity and quality.



Metso Outec

The travelling grate induration process (diagram) is responsible for two-thirds of the world's installed iron-ore pelletizing capacity. "The main sources for CO_2 in pelletizing are fossil fuels and of course the CO_2 footprint of the electrical energy," explains Maximillian Köpf, director Technology and R&D, BL Ferrous & Heat Transfer at Outotec GmbH & Co. KG (Oberursel, Germany).

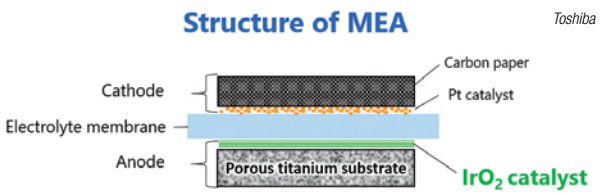
For additional energy savings, the company is also working on developing new heat recuperation and advanced combustion concepts to optimize energy efficiency, explains Köpf. The LowNOx burners were recently launched (*CE*, May 2022, p. 8), and H_2 burners will follow soon. Already successfully implemented is the so-called hot-gas cooling concept, which is dividing the cooling zone into three subzones and creating an internal cooling zone recycle. The benefits of this design are a reduction of total gas volumes and thermal energy consumption. Additionally, it also reduces the thermal shocks and improves product quality.

Metso Outotec is also working on a completely new hood concept for the induration furnace that simplifies the design and reduces the investment cost. It also improves the temperature control and homogeneity in the furnace and thus energy-efficiency and product quality.

Improved production, availability, and product quality are achieved by a combination of optimizing the process steps, such as green pelletizing (formation of the pellets), screening of these green pellets before the induration step, the smooth feeding to the furnace and of course, the induration itself, explains Köpf. All these improvements are supported by the company's advanced process-control system, Optimus.

Sputtering process enables production of large, iridium-lean MEAs

Polymer electrolyte membrane (PEM) electrolysis uses a membrane-electrode assembly (MEA) that integrates the electrolyte membrane and electrode (diagram). Large-scale hydrogen conversion of electricity requires a large number of MEAs, which is a drawback for scaleup, because the MEA relies on a large amount of iridium — one of the rarest of all traded precious metals — to ensure sufficient electrolytic efficiency. Forming electrodes requires a uniform coating of fine IrO_2 particles, but reducing the amount of IrO_2 results in uneven application and non-uniform reactions that degrade water electrolysis performance.



Back in 2017, Toshiba Corp. (Tokyo, Japan; www.toshiba.com) developed a laminated, IrO_2-nanosheet catalyst that reduced the Ir requirement to one tenth of that used by current PEMs — but only at the laboratory scale. Now, the company developed a sputtering technique that can form large areas of multilayer catalyst. In the sputtering process, ions (such as argon ions) bombard Ir-metal targets in a vacuum chamber. Particles ejected (sputtered) from the target then deposit on a substrate. By injecting O_2 during the deposition, alternate layers of IrO_2 nanosheet films and void layers are formed. With this process, the company has been able produce uniform multilayer catalyst on areas up to 5 m^2.

In collaboration with Toshiba Energy Systems & Solutions Corp., Toshiba has built MEA prototypes with electrodes based on the developed technology, and has begun evaluation testing with a water electrolyzer manufacturer. The company is working to improve the yield and quality toward mass production of MEA, aiming for commercialization as soon as Fiscal Year 2023.

ronments, aboard fishing vessels and more.

The patented fluids are readily biodegradable, renewable, fire resistant, EPA- and ISO 1400-compliant, and contain no volatile organic compounds (VOCs). The fluids are available in 5-gal pails, 55-gal drums, 275- and 330-gal totes and bulk.

'GREEN' TIRES

Evonik Industries AG (Essen, Germany; www.evonik.com) has entered a strategic cooperation with the Pörner Group (Vienna, Austria; www.poerner.at) and Phichit Bio Power Co., Ltd. (Phichit, Thailand), to supply sustainable Ultrasil precipitated silica to tire manufacturers. The key raw material for the sustainable silica is sodium

(Continues on p. 8)

silicate, which is derived from rice husk ash (RHA), an agricultural waste product, and produced exclusively with green energy.

The new collaboration addresses the pressing needs of more sustainable tire production and the industry's ambition to increase the use of renewable raw materials. Pörner Group's pioneering process to generate the silicate from RHA uses biomass energy that enables Evonik to deliver a CO_2 footprint reduction of up to 30% compared to its standard silica. Phichit Bio Power Co., Ltd. with its existing rice mills and biomass power plants, licenses Pörner Group's technology and will invest in a new RHA sodium silicate plant in Thailand, slated for commissioning in 2024. This step allows Evonik to scale up a reliable supply of bio-based sodium silicate to meet the global tire industry's demand for more sustainably produced silica.

Silica is the key-ingredient for fuel-efficient tires, reducing the fuel consumption by up to 8% compared to conventional passenger car tires.

'BIO' BATTERY

Researchers from Sintef (www.sintef.no) and the Norwegian University of Science and Technology (both Trondheim, Norway; www.ntnu.edu) have developed a battery that stores thermal energy using a bio-based phase-change material (PCM). At the Zero Emission Building (ZEB) laboratory in Trondheim, a prototype heat-storage device has been operating for a year. The device consists of a vessel

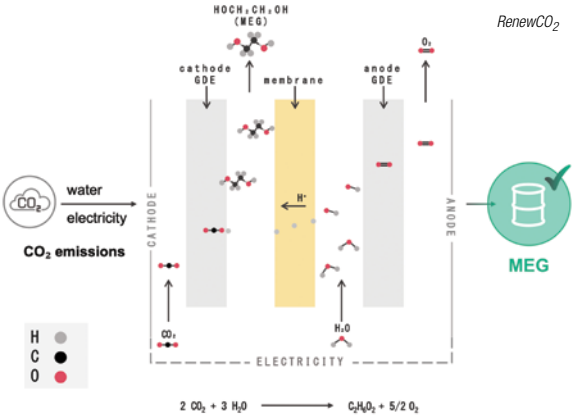
(Continues on p. 9)

Selective production of MEG from CO_2 in a single step

The startup company RenewCO$_2$ (Piscataway, N.J.; www.renewco2.com) has developed a catalyzed electrochemical process for selectively producing monoethylene glycol (MEG) in a single step using byproduct carbon dioxide from other processes as feedstock. MEG is important industrially because it is the monomer used for production of polyester fiber and polyethylene terephthalate (PET) plastic.

RenewCO$_2$'s process, known as eCUT-MEG, is synergistic with polyester production because polyester manufacturing generates CO_2 as a byproduct, explains Karin Calvinho, co-founder and CTO of RenewCO$_2$. "So our process can 'piggyback' onto already existing polyester production and make carbon-negative materials," she says.

The core enabling technology for RenewCO$_2$'s MEG process is a nickel-phosphide catalyst material with a specific crystal structure and stoichiometry on its surface that directs MEG selectivity. The catalyst is integrated into an electrochemical cell, where a voltage is applied to provide sufficient energy for the initial removal of hydrogen from water (see diagram). In the process, CO_2 is reduced to formate with the addition of a proton at the cathode. The formate is then converted to formaldehyde over the Ni-phosphide catalyst.



MEG is formed through an aldol-coupling reaction of two aldehyde molecules to form a C–C bond, with O_2 evolved at the anode.

"The reaction proceeds via a hydride-transfer mechanism, without any high-energy or toxic intermediate species," says co-founder and CEO Anders Laursen. "So the energy penalty is low, and the surface crystal structure can be tuned to form other products, such as 3- or 4-carbon species," he says.

The company has already brought the process from batches to a fully continuous process and tested simulated captured CO_2, and now plans to build a pilot plant. In October, RenewCO$_2$ received funding from Breakthrough Energy, the clean-energy investment fund started by Bill Gates, and will use the funding to develop the pilot plant.

World's largest AEM electrolyzer launched in California

An emerging electrolyzer technology for renewable hydrogen production is the anion-exchange membrane (AEM), which provides efficiency and cost benefits over other electrolyzer configurations. Until now, most AEM installations have been small, as the membrane assemblies' size and durability limited the operating capacity and lifetime. Now, Verdagy (Moss Landing, Calif.; www.verdagy.com) has achieved 1,000 operating hours for a 20-kW AEM demonstration plant. In conjunction with this milestone, the company is launching commercial electrolyzer modules that incorporate the world's largest AEM cells (28,500 cm^2). "Taking learnings from chlor-alkali processes, we used a robust single-cell architecture. The interior architecture of the cell is designed to avoid all of the failure modes of membranes at high current densities, including localized heating, hotspots, slugging and plugging, while encouraging high circulation rates and uniform energy distribution," explains Marty Neese, CEO of Verdagy.

The high current density of AEM cells is key to their performance and cost benefits. With alkaline electrolyzers, gas crossover, the physics related to diaphragms and the porous nature of the separators create limitations on achievable current densities, says Neese. This means that significantly fewer AEM cells would be required to achieve the same output than with alkaline cells. "For example, a 20-MW AEM electrolyzer with our design would use around 160 cells. If you were looking at the nearest best-in-class alkaline competitor, it would be closer to 300," he adds.

Verdagy says this is thus far the largest demonstration of an AEM cell being used for H_2 production. The current density and scale being demonstrated make these cells suitable for a wide variety of applications, including decarbonizing electric-arc furnaces in steel plants and processes that are directly coupled to intermittent power sources. Verdagy is continually working to scale up the cells' capacity and is also working on commercial feasibility studies with interested parties in the chemical and petrochemicals industries.

New method selectively extracts magnesium salt from seawater

Magnesium metal is important for several emerging potential sustainability-related applications, including carbon capture, low-carbon cement and energy storage. These potential applications are driving efforts to efficiently produce magnesium hydroxide, the raw material for manufacturing Mg metal. It is possible to harvest $Mg(OH)_2$ from seawater, but the existing process results in a complex mixture of magnesium and calcium salts, which are difficult and costly to separate.

Now, researchers at the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL; Richland, Wash.; www.pnnl.gov) and the University of Washington (Seattle; www.washington.edu) have developed a method for extracting pure $Mg(OH)_2$ from seawater, eliminating the need for energy-intensive purification steps to remove Ca-based impurities.

Scientists have long known that adding sodium hydroxide to seawater can precipitate $Mg(OH)_2$, but doing so unavoidably results in $CaCO_3$ also. The PNNL researchers developed a laminar co-flow method (LCM), in which a NaOH solution and seawater are co-injected into a microfluidics device. The LCM is designed to create non-equilibrium conditions at the interface of the two fluids. These conditions allow the selective precipitation of $Mg(OH)_2$, unlike the conventional bulk mixing method.

As the seawater and NaOH solution flow alongside each other in the device, the magnesium-containing seawater quickly reacts to form a layer of solid $Mg(OH)_2$. This thin layer acts as a barrier to solution mixing, the researchers say.

"The flow process produces dramatically different results than simple solution mixing," says PNNL postdoctoral researcher Qingpu Wang, adding, "The initial solid magnesium hydroxide barrier prevents calcium from interacting with the hydroxide."

In addition to selectively producing pure solid $Mg(OH)_2$, LCM could also be integrated as a pretreatment step in seawater desalination processes. The researchers say the method could be scaled up in a straightforward way and they hope to explore LCM as a way to selectively separate other materials from complex feed streams. ■

containing 3 metric tons of "biowax" (melting point of 37°C), a heat pump, heat exchanger and piping. The battery can be "charged" using energy from solar electricity, waste heat from a factory or surplus energy from a wind turbine. To utilize the stored heat, water is circulated through the system where it can then be used for heating needs. This container makes it possible to store heat energy generated on sunny and windy days and release it again when the weather gets colder.

The researchers are working to develop smart control systems with the aim of optimizing output, and are in the process of establishing a company to commercialize the technology. Several pilot-scale systems are being planned with industrial partners for 2023–2024. ❐

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Plant Watch

Covestro breaks ground in Antwerp for new aniline plant

October 12, 2022 — Covestro AG (Leverkusen, Germany; www.covestro.com) broke ground in Antwerp, Belgium for a new world-scale production facility for the manufacture of aniline. Covestro is investing more than €300 million in the plant, which is scheduled to be operational in early 2025.

SGP BioEnergy adds green-hydrogen production to Panama biorefinery project

October 12, 2022 —SGP BioEnergy Holdings LLC (Philadelphia, Pa.; www.sgpbioenergy.com) plans to add green-hydrogen production to its biofuels project in Panama, the largest-planned advanced biorefinery in the world. Facility construction is on schedule for Phase 1 production to begin in 2025, following the commencement of physical construction in 2023. Once fully operational, the biorefinery will produce 180,000 barrels per day of biofuels and 405,000 metric tons per year (m.t./yr) of green hydrogen.

OMV Petrom to build new aromatics unit at Petrobrazi Refinery

October 12, 2022 — OMV Petrom S.A. (Bucharest, Romania) is investing approximately €130 million over the next three years to build a new production unit for aromatic products at the Petrobrazi Refinery in Romania. The processing capacity of the new unit is about 1,500 m.t./d. The new unit will be put into operation in 2026.

BASF to construct new neopentyl glycol plant in China

October 11, 2022 — BASF SE (Ludwigshafen, Germany; www.basf.com) will invest in a new world-scale neopentyl glycol (NPG) plant with a production capacity of 80,000 m.t./yr at its new Zhanjiang *Verbund* site in China. With the new NPG plant expected to come onstream in late 2025, BASF's global NPG capacity will be boosted from 255,000 m.t./yr to 335,000 m.t./yr. Currently, BASF has NPG production facilities in Ludwigshafen, Germany; Freeport, Tex.; and Nanjing and Jilin, China.

Toray to increase production capacity for polyester films at Gifu Plant

October 11, 2022 — Toray Industries, Inc. (Tokyo; www.toray.com) will boost production capacity by 60% for the Lumirror brand of biaxially oriented polyester-release films used in the manufacture of multilayer ceramic capacitors. The company will invest ¥8 billion (around $54 million) in this upgrade at the Gifu Plant in Japan. The upgraded capacities will go online in 2025.

Cepsa begins production of advanced biofuels at La Rábida Energy Park

October 7, 2022 — Cepsa Quimica (Madrid, Spain; chemicals.cepsa.com) has started to produce advanced biofuels with used cooking oils as feedstock at its La Rábida Energy Park, located in Huelva, Spain. Cepsa expects its total biofuels production capacity in Spain and Portugal to reach 2.5 million m.t./yr by 2030.

Air Products investing $500-million in a new green-hydrogen facility in New York

October 7, 2022 —Air Products (Lehigh Valley, Pa.; www.airproducts.com) announced plans to invest approximately $500 million to build, own and operate a 35-m.t./d facility to produce green liquid hydrogen at a greenfield site in Massena, N.Y., as well as liquid-hydrogen distribution and dispensing operations. The commercial operation of this facility is targeted to begin in 2026 or 2027.

Honeywell opens plant in Baton Rouge to produce new low-GWP propellant

October 6, 2022 — Honeywell International, Inc. (Charlotte, N.C.; www.honeywell.com) opened a plant in Baton Rouge, La., which is the company's first large-scale manufacturing site for Solstice Air (HFO-1234ze(E) cGMP), a near-zero global-warming-potential (GWP) medical propellant. Honeywell is partnering with AstraZeneca plc (Cambridge, U.K.; www.astrazeneca.com) to incorporate Solstice Air technology into inhaled respiratory medicines.

Orlen Unipetrol commissions dicyclopentadiene production unit

October 6, 2022 — The Orlen Unipetrol Group (Prague, Czech Republic; www.orlenunipetrol.cz) has commissioned a new production unit for dicyclopentadiene (DCPD), which will produce up to 26,000 m.t./yr of DCPD, making it one of the largest producers in Europe. The investment in the construction of the new unit totaled CZK831 million (around $33 million). DCPD, a liquid hydrocarbon, has a broad range of applications in the automotive industry, construction, electrical, medicine and pharmaceutical sectors.

Mergers & Acquisitions

Entegris to sell its Pipeline and Industrial Materials business to Infineum

October 12, 2022 — The Pipeline and Industrial Materials business (PIM) of Entegris, Inc. (Billerica, Mass.; www.entegris.com) will be acquired by Infineum, a joint venture (JV) between Shell and ExxonMobil. Entegris' PIM business is part of the company's Specialty Chemicals and Engineered Materials division and includes sealant products and drag-reducing agents (DRAs) for pipeline operations.

LyondellBasell forms two plastics-recycling JVs

October 11, 2022 — LyondellBasell Industries (Rotterdam, the Netherlands; www.lyondellbasell.com) announced the formation of two JVs related to plastics recycling. The first, with Chinese firm Genox Recycling, will construct a plastics recycling plant in Zhaoqing, Guangdong Province with a planned startup in 2023. The second JV, called Source One Plastics, is a partnership with 23 Oaks investment to build an advanced plastic-waste sorting and recycling facility in Germany.

Chemours announces fuel-cells JV in Germany

October 11, 2022 — The Chemours Co. (Wilmington, Del.; www.chemours.com) plans to enter into a JV with BWT Fumatech Mobility GmbH focused on membrane manufacturing for fuel-cell technologies. The companies estimate that within 12 months of startup, the JV, called Mobility F.C. Membranes Co., will ramp up capacity for manufacturing heavy-duty humidifier and fuel-cell membranes.

BASF and Hannong Chemicals form JV for non-ionic surfactants

October 6, 2022 — BASF and Hannong Chemicals are planning to establish a production JV in which BASF will hold 51% and Hannong Chemicals 49% shareholding. The JV will supply non-ionic surfactant products to BASF and Hannong Chemicals, and will be located in the Daejuk site at the Daesan Industrial Complex in Korea. Non-ionic surfactants are used in a wide range of industry segments, including home care, personal care and institutional and industrial cleaning applications.

Solenis to acquire paper-process chemicals business of KLK Kolb

September 30, 2022 — Solenis LLC (Wilmington, Del.; www.solenis.com) agreed to acquire the paper-process chemicals business of KLK Kolb Group (Hedingen, Switzerland; www.kolb.ch). KLK Kolb Group's paper process chemicals portfolio includes deposit control, cleaning and foam control agents. The transaction is expected to be completed before the end of the first quarter of 2023.

Nouryon acquires Polish fertilizer manufacturer ADOB

September 30, 2022 — Nouryon B.V. (Amsterdam, the Netherlands; www.nouryon.com) will acquire ADOB Fertilizers, a supplier of chelated micronutrients, foliars and other specialty fertilizers located in Poland. The transaction is expected to close by year-end 2022.

Borealis sells stake in Rosier fertilizer business for €35 million

September 26, 2022 — Borealis Group (Vienna, Austria; www.borealisgroup.com) and Yildrim Group (Istanbul, Turkey) signed a binding agreement for the acquisition of Borealis' shares in fertilizer business Rosier S.A. The offer values the business at €35 million.

Orlen Unipetrol acquires recycling firm Remaq

Orlen Unipetrol is acquiring Rema, s.r.o. Remaq focuses on production and trading of plastic recyclates, and operates a production plant with four regranulation lines totalling 2,400 m.t./mo of processing capacity. ■

Mary Page Bailey

Pressure Transmitters for Enhancing Uptime

New materials, digitalization and simplified user interfaces reduce downtime and ensure safety in pressure-measurement applications

Optimizing uptime and safety are among the two highest priorities for chemical processors, making reliability in pressure-measurement devices essential to ensuring that key processes are safely up and running as much as possible. Developments in pressure-measurement instrumentation, including new designs and materials of construction, digitalization and simplified user interfaces, are intended to provide reliability, enhance safety and improve productivity. These are especially crucial at a time when processors are challenged by reduced workforces and tighter budgets while trying to maintain production goals.

"Chemical processing is a broad industry with many applications, different process fluids and extreme conditions in both pressure and temperature," explains Brad Burton, pressure senior product manager with Emerson (Shakopee, Minn.; www.emerson.com). "User need pressure measurement devices that can safely withstand harsh process conditions, offer a broad range of materials of construction for corrosion resistance, maintain reliability in high-pressure applications and operate across a broad range of both ambient and process temperatures," he says.

"Processors are also dealing with attrition in staff and loss of tribal knowledge, as well as the need to increase productivity and reduce downtime," adds Keith Riley, product marketing manager for level and pressure products with Endress+Hauser (Greenwood, Ind.; www.us.endress.com). "So, it becomes necessary to consider the needs of the application and align those needs with fit-for-purpose devices that meet the application requirements but also provide increased productivity, smart safety and simplicity."

Reliability & safety

To meet the needs of today's chemical processes, providers of pressure-measurement devices are constantly working to overcome known industry challenges via new materials and solutions.

One example of application-specific design includes solutions that manage the challenges associated with hydrogen, as processors strive to reduce carbon emissions. "Hydrogen is one of the big challenges driven by the need for alternative fuel sources," says Sean McNutt, product manager of pressure, temperature and valve positioners, with Siemens Industry, Inc. (St. Paul, Minn.; www.siemens.com). "Hydrogen generation is a growing part of the chemical processing industry, but hydrogen damages the inner workings of pressure transmitters, which are typically made of stainless steel. However, gold stops hydrogen molecules from working their way into the transmitter, so we now offer gold-plated diaphragms in instrumentation. Because hydrogen is a growing trend, we are working toward expanding our offering of gold-plated diaphragms to include both differential and standard pressure measurement devices."

Stainless steel is also not the best solution in vacuum applications, notes Jason Kuzmiak, chemical industry manager for North America, Western U.S., with VEGA Americas, Inc. (Mason, Ohio; www.vega.com). "Stainless-steel seals tend to fail under vacuum, so if the temperatures and pressures of the applications allow, we offer a ceramic cell for our Vegabar 80 series that overcomes the distortion of the measurement cell in vacuum applications."

FIGURE 1. The Vegabar 82 series with a ceramic-based cell is resistant to media that contain abrasive materials

Jeff Brand, pressure product manager, with VEGA, adds that the Vegabar 82 series with a ceramic-based cell (Figure 1) would also be more resistant to media that contain abrasive materials that could scratch or damage a metallic surface. "In difficult applications, the transmitter will hold up for a longer period of time with a ceramic-based cell, which increases safety and reliability, enhancing productivity in these applications," he says.

Also seeking to improve safety in extremely hazardous processes, such as those that contain phosgene or other very toxic chemicals that must not leak into the ambi-

FIGURE 2. Siemens' P320 and P420 transmitters are available with a high-protection cell for use in processes that contain highly toxic chemicals, such as phosgene

ent atmosphere, Siemens offers a new high-protection measuring cell. "Adequate sealing in highly toxic applications is always a concern so you can't rely on tapered threads. A welded or gasketed seal is necessary to prevent unintentional leaks in these applications," says McNutt. "In response, we developed a high-protection cell that adds an extra stainless-steel-welded barrier between the process and the electronics. That is then filled with glass to prevent more permeation and provide another layer of protection."

He continues, "The key to this development is not just protecting, but also detecting, so in addition to preventing the escape of toxic materials, there is a sensor inside the device — in the form of a small conductor strip that will erode if it comes in contact with the process material — that will alert users if the primary seal has failed." This high-protection cell is available on Siemens' P320 and P420 transmitters (Figure 2).

To deal with thermal-induced drift, another common challenge in the chemical process industries (CPI), Endress+Hauser offers TempC, a unique diaphragm-seal membrane that helps increase reliability and accuracy of the measurement in pressure and differential-pressure applications where thermal-induced drift is known to skew the measurement. "Typically, when a transmitter is placed in an area where the ambient temperature varies, the fill fluid in the capillary of a pressure device expands and contracts accordingly," says Riley. "The problem is that the expansion pushes against the diaphragm, which can only give so much, and the remaining expansion is forced against the pressure sensor, which will then indicate a false change in pressure. The TempC membrane, without giving up durability, can absorb more expansion and contraction, reducing thermal drift and providing a more reliable and accurate measurement, regardless of what's happening with the ambient temperature."

Also dealing with ambient-related influences on differential pressure applications that typically require insulation or heat tracing to avoid thermal-induced drift, VEGA developed a new electronic differential pressure (EDP) technology. "While more traditional differential pressure applications sometimes require insulation and heat tracing to avoid thermal-induced drift, our EDP technology provides an alternative," says Eric Moore, chemical industry manager for North America, Eastern U.S., with VEGA. "EDP features two separate pressure sensors connected electronically so they can share information. Because the wires are electronic, they are not susceptible to environmental conditions the way traditional differential-pressure transmitters would be. While it's not a solution that can be used in every differential-pressure scenario, where it fits, it is a fantastic solution to eliminate ambient-related influences on the transmitter, which helps boost reliability of the measurement."

Benefits of digitalization

"Digitalization is changing the landscape of the CPI [chemical process industries] and users need access to more data to run the plant more efficiently, so they are looking to add more devices in a cost-effective way," says Emerson's Burton. "Wireless pressure transmitters can deliver quick instrumentation measurement points without the cost of wiring, providing the data needed to improve operations. These devices can be installed in hard-to-reach areas or in dangerous plant environments. This makes reliable pressure measurement very important in light of efforts to improve safety by minimizing the time plant personnel spend in the field."

In addition, wireless-enabled pressure transmitters allow for remote configuration of the device while providing access to diagnostic information without having to physically connect to the device, continues Burton. "Operators in the CPI often lack insight into the health of their pressure transmitters, so diagnostic alerts transmitted via the HART protocol can help users identify the need for maintenance before measurement issues result in process downtime," he says. Further, investments in advanced diagnostics, such as loop integrity and plugged impulse line detection, such as are available with the Rosemount 3051 transmitter (Figure 3), help users detect issues in delivering an accurate reading to host systems. These diagnostics identify issues that could result in the control system receiving incorrect measurements, potentially leading to safety- and quality-compromising decisions.

McNutt from Siemens adds that another recent development includes the addition of on-board data logging in pressure transmitters. "This can be built into the transmitter and independent from the distributed control

FIGURE 3. Advanced diagnostics, such as loop integrity and plugged-impulse-line detection, such as are available with Emerson's Rosemount 3051 transmitter, help users detect issues in delivering an accurate reading to host systems

Endress+Hauser

FIGURE 4. Endress+Hauser's Cerabar PMP71B offers remote control to verify and monitor functions to help detect unwanted anomalies

system (DCS) or programmable logic controller (PLC), allowing users to keep a trend log and event counters and perform limit-monitoring stored on the device itself so they can see if a reading is drifting over time. You can track frequent pressure spikes or other issues to see if there are potential problems that indicate that service might be needed or if something is amiss further downstream in the process," he explains. "This helps optimize maintenance schedules and lets your devices serve as your eyes and ears, rather than waiting for something to go wrong."

In addition, says Andrew Brodie, GM, modular control systems, with Honeywell Process Solutions (Charlotte, N.C.; www.honeywell.com), there has been an introduction of versatile handheld tools that, together with lifecycle-software solutions, provide users with a single view of their field instrument assets. Honeywell's Versatilis configurator and lifecycle software work together to give complete control over process instrumentation, including pressure transmitters, and peace of mind that everything is working in concert to keep the facility productive and safe. The configurator is an app-based, Bluetooth-enabled tool that encourages rapid connection and configuration to reduce setup times, eliminate configuration errors and identify and resolve faults in the field, while the lifecycle app manages instrument lifecycle, including documentation, support, spares and replacement, saving time and ensuring uptime.

Users can expect to see a new trend in process automation, as well. Ethernet-APL will bring Ethernet to the device level in plant environments where this has not been possible in the past. Ethernet-APL delivers power and digital communications to field devices via twisted-shielded pair wire, supports wiring distances up to 200 m and is suitable for installation in hazardous locations, notes Emerson's Burton. "The updated physical layer provides the simplicity of common twisted-shielded pair cable with screw terminals, while enabling the delivery of Ethernet to the device." (For more on Ethernet-APL, see "Ethernet.APL: The Future of Field Connectivity," *Chem. Eng.* August 2022, pp. 31–36).

New interfaces

"Chemical processors are working to increase uptime but are also dealing with a loss of tribal knowledge so there has been a focus on simplicity and ease of use in pressure measurement (and other devices)," notes Endress+Hauser's Riley. "Intuitive simplicity relieves some of the burden of attrition and helps ensure safety, reliability and productivity."

Two areas of simplification include communicating device alerts and messages in clear and concise terminology and making commissioning of instrumentation easier, he says. "We are seeing more prevalent use of visual icons that provide insight into transmitter status on the display. These icons are easy-to-understand, dashboard-like symbols that identify whether there is a maintenance issue or something more severe. This is accompanied by an English-language explanation of what the error code indicates, so users know exactly what is wrong and receive instructions on the proper corrective action for that alarm. This can help reduce the time it takes to decipher an alarm and receive a diagnosis from 30 to 40 minutes down to about five," explains Riley. "This user-friendly development helps reduce unscheduled maintenance and assists with prioritizing maintenance activities."

Likewise, VEGA introduced the Vegabar 20/30 Series, which features light rings to simplify visual indication. "Users can employ up to five colors to rank various degrees of transmitter output ranges so technicians can see at a glance what is going on with the pressure device just by poking their head into a room. This cuts down on the time they used to spend checking the display on each instrument," says Moore. "The process values, along with the switching state, are sent to the control room where automation of previously manual systems can be implemented."

Instrument providers are also simplifying the commissioning process. "We are employing instrument-guided commissioning within our devices to lead users through the process. The 'Commissioning Wizard' walks the user through necessary questions and then alerts them when the task is complete, which helps increase efficiency of the commissioning process for each instrument by about 30%," explains Riley. "It also helps with specialized commissioning processes for SIL [safety integrity level] instrumentation in which the 'SIL Check Wizard' requires the user to verify SIL-relevant parameters in a read-only format before being permitted to finish and lock down the instrument. This reduces systematic failures, such as operator errors and other common mistakes."

This is available on several of Endress+Hauser's pressure transmitters, including the Cerabar PMP71B (Figure 4), which also offers remote control via an application on a mobile device using a secure Bluetooth connection and Heartbeat Technology to verify and monitor functions to help detect unwanted anomalies such as changes in loop characteristics.

"At a time when chemical processors are doing more with less, there is a universal need for simplicity, smart safety and increased productivity and today's pressure measurement devices are more able to provide those than ever before," says Endress+Hauser's Riley. ■

Joy LePree

Equipment for H_2 Service

Pressure-measuring devices for hydrogen

Hydrogen is considered a difficult medium because its particularly small molecules can penetrate even stainless steel and also damage a material's structure, causing embrittlement or cracks. It is therefore extremely important that measuring devices for H_2 applications are made of the right materials. This company has developed several series of pressure transmitters that can be used in both standardized and application-defined H_2 processes. The measuring instruments of the Pascal CV4 (photo) and Pascal Ci4 series, as well as Compact CA16, cover a measuring range between –1 and 1,050 bars, depending on the capabilities of the individual pressure transmitter, can be used in temperatures down to –40°C and are also certified with Ex- protection and some with SIL. *— Labom Mess- und Regeltechnik GmbH, Hude, Germany*
www.labom.com

Oil-free screw compressor for compressing electrolysis H_2

The design and water injection of the new compressor stage of the VRW536M (photo) allow the highest differential pressure to date in a single-stage oil-free screw compressor. Compression is based on the principle of oil-flooded screw compressors, except the oil is replaced by water. The water serves both to cool the gas and to seal the internal gaps, enabling compression to higher differential pressures with the highest efficiency. This stage can, thus, replace a two-stage system with classic dry screw compressors, and is even more energy-efficient. The VRW536M is designed for an operating pressure of up to 10.0 bara and a volume flow of up to 6,000 Nm^3/h at 50 Hz. Predrying of the humid H_2 gas is not necessary. Double-acting, water-purged mechanical seals on the conveying chamber ensure 100% oil-free operation. *— Aerzener Maschinenfabrik GmbH, Aerzen, Germany*
www.aerzen.com

A cryogenic valve for hydrogen applications

Liquefied gases, such as hydrogen, are generated, transported and stored at cryogenic temperatures near absolute zero. Such temperatures call for specially engineered valves capable of resisting these conditions. The Type 3248 Cryogenic Valve (photo) is such a valve. All wetted valve parts are made of materials with defined alloy compositions. They withstand the extremely low temperatures, showing no signs of impaired strength and viscosity even after longer periods of controlling the process medium. *— Samson AG, Frankfurt am Main, Germany*
www.samsongroup.com

New valves for hydrogen-fueling stations

The Tescom Anderson Greenwood Instrumentation H_2 Valve Series (photo) is suitable for hydrogen applications up to 15,000 psi (103.4 MPa). The new valve reliably isolates process pressure in high-pressure gas applications, such as H_2 fueling stations and tube trailers, reducing fugitive emissions and improving safety. The double-block-and-bleed valve's positive double block arrangement provides two layers of positive shutoff that shield maintenance staff from high pressure during instrument maintenance. Its modular design reduces the number of potential leakage points, and the reinforced sealing technology reduces the risk of fuel entering the atmosphere through the valve stem. The hand-operated, maintenance-free design of the hand valves and double block and bleed valves in the H_2 Valve Series minimizes maintenance and downtime. *— Emerson, St. Louis, Mo.*
www.emerson.com

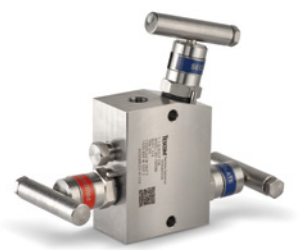
Full service for hydrogen supplies to service stations

Since the beginning of the year, this company has consolidated its full-service portfolio of service station logistics and specialized gas logistics. The provision of transport services to the European service station net-

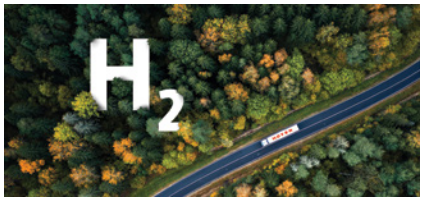
Labom Mess- und Regeltechnik

Aerzener Maschinenfabrik

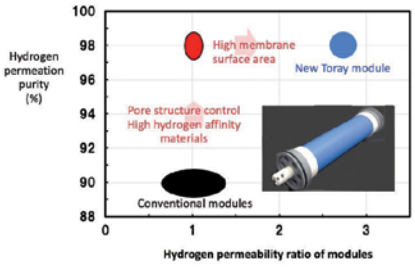
Samson



Emerson



Hoyer



Toray Industries

Sundyne

works is now also available for alternative fuels, such as H_2. In doing so, the company supports the infrastructural change for the energy transition, and positions itself as a pioneer in the intelligent inventory management of H_2 fuels at service stations. By combining its know-how in handling gases with experience in digital, system-supported supplies to service stations, the company now also offers automated, prediction-based product inventory management and supply logistics for H_2 as well. For Europe, the company transports both compressed gaseous H_2 and cryogenically liquefied H_2. — *Hoyer GmbH, Hamburg, Germany*
www.hoyer-group.com

Polymeric membrane module for H_2 separation

Earlier this year, this company introduced a new polymeric membrane module that can selectively and efficiently permeate H_2 from mixed gases. This module more than halves the CO_2 emissions of H_2-purification processes, says the company. The membrane has double the area of conventional separation membrane modules, which improves the hydrogen permeability of a module (photo) and more than halves the number of module elements needed for the hydrogen purification process. The company will partner with engineering companies in Japan and abroad while drawing on process technologies from water treatment to establish mass production techniques. — *Toray Industries, Inc., Tokyo, Japan*
www.toray.com

Compressors for hydrogen applications

The PPI line of diaphragm compressors (photo) is specifically designed to address the challenges associated with compressing H_2 from low pressure levels (such as electrolyzer outlet pressure) up to levels that are required by today's vehicles that run on H_2. PPI compressors feature triple diaphragm sets, which ensure that the process gas is isolated from the hydraulic oil to ensure absolute process purity. Every process-contacting part in a PPI compressor is made from corrosion-resistant alloys, making them ideal for H_2 processing, as well as other applications involving hazardous gases. The static seals in PPI compressors ensure zero leakage of process gas to the atmosphere, and PPI's leak detection system immediately detects diaphragm or seal failure. All PPI compressors meet API 618 standards. — *Sundyne, Arvada, Colo.*
www.sundyne.com

Handle hydrogen blending with these gas regulators

The Government target for Britain's network of gas pipes aims to deliver 20% H_2 nationwide from 2023. However, addressing specific integrity and safety issues will be essential if this goal is to be reached. Through identifying the key challenges facing H_2 blending, as well as keeping improvements of existing gas networks in mind, this company has developed its own approach to future-proof gas regulators within the gas distribution system. The IM-S gas regulator (photo) is manufactured from 316 stainless steel, which is acknowledged to be less susceptible to hydrogen embrittlement. Furthermore, they do not feature large elastomeric diaphragms, which, research suggests, fare less well in trials of hydrogen transmission at various pres-

sures, with leaks a common issue. By eliminating the diaphragm and reducing the risk of regulator fatigue and failure, the IM-S regulator minimizes the risk of unplanned maintenance — maximizing efficiency and reducing operating costs whether hydrogen blending is present in a network or not, says the company. — *Oxford Flow Ltd., Oxford, U.K.*
www.oxford-flow.com

The first manufacturer to run OPC UA on its electrolyzers


Enapter

Last September, this company became the first electrolyzer producer running the popular Open Platform Communications Unified Architecture (OPC UA) communication standard on its electrolyzers. OPC UA is one of the world's most important communication standards for industrial automation and Industry 4.0. Known by some as "the global production language," OPC UA enables improved data communication and interoperability between devices and systems in many industries. While its EL 4.0 Electrolyzers (photo) running OPC UA will be able to enable easy and secure integration with third-party energy management systems (EMS), the company also offers users its own EMS Toolkit for integration and control of its own and third-party devices. — *Enapter AG, Berlin, Germany*
www.enapter.com

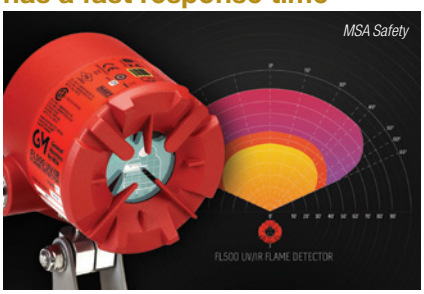
Electrolysis components to be mass produced in 2025

Earlier this year, this company announced plans to branch out into the development of components for electrolyzers running on sustainable energy (photo). In collaboration with a number of partners, the company aims to develop a way of combining the electrolyzer stack with a control unit, power electronics, and various sensors to create a "smart module." With pilot plants scheduled to commence operation in the coming year, the company plans to supply

Robert Bosch

these smart modules to manufacturers of electrolysis plants and industrial service providers from 2025 onward. Unlike many of the electrolyzer components currently on the market, these smart modules will be mass produced to take advantage of economies of scale. — *Robert Bosch GmbH, Stuttgart, Germany*
www.bosch.com

This compact flame detector has a fast response time



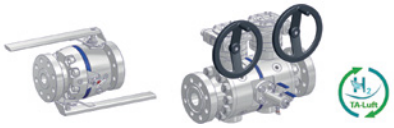
MSA Safety

The FL500 UV/IR Flame Detector (photo) monitors for radiation emitted by a flame in both the ultraviolet (UV) and infrared (IR) spectral ranges. This combination UV/IR optical sensor provides the fastest response time and increased false-alarm immunity against common plant sources of radiation, such as tanks and large pipes, for more reliable protection. Avoiding false alarms reduces process and plant down time, as well as increases employee confidence in safety systems should an actual incident occur. A helpful FL500 Flame Detector Simulator is now available on this company's website, which colorfully illustrates the field-of-view (FOV) protection afforded by this sensing technology in a variety of fuel environments, including hydrogen. Simulator viewers can see and compare the flame sensor's FOV for common fuel sources including butane, ethane, heptane, hydrogen, methane, methanol and propane. The FL500 detector offers a wide field of view (up to 130 deg). — *MSA Safety Inc., Cranberry Township, Pa.*
www.msasafety.com

Gerald Ondrey

New Products

Schenck Process



Armaturenfabrik Franz Schneider

Kubota Brabender Technologie

Kaeser Kompressoren

Vertical cartridge filter for industrial dust collection

The Vertical Cartridge Filter (VCF; photo) is a pulse-jet filter designed to handle medium to high air volumes for industrial dust removal. It is typically used as a nuisance dust collector in applications with light dust loads and a high volume of air flow. An easy-to-use cartridge clamp system on the hinged front doors of the baghouse provides easy access to and rapid replacement of the filter media. This minimizes downtime during scheduled maintenance, decreasing overall cost of operation. The filter is equipped with a smart timer, which includes an on-board sensor that reads the pressure drop across the filtering elements for on-demand cleaning. This results in reduced compressed-air consumption and greater cartridge life, the company says. — *Schenck Process LLC, Kansas City, Mo.*
www.schenckprocess.com

Dynamic digital valve tool introduced at Valve World

A highlight of this company at Valve World 2022 (November 29–December 1; Düsseldorf, Germany) is the new Digital Valve Kit (DVK), which provides plant operators with remote access and remote control of their valves, as well as indicating the current health status of the installed valves. The DVK provides all alerts to the maintenance team in a timely manner. This enables them to react in time and initiate further measures at an early stage. The company is also exhibiting its range of valves and manifolds, as well as the DBB ball valves (photo), which are suitable for hydrogen applications. The instrumentation and piping valves can also be used safely in natural gas applications with, for example, a 20% hydrogen blending. Hall 3, Booth B20 — *Armaturenfabrik Franz Schneider GmbH + Co. KG, Nordheim, Germany*
www.as-schneider.com

This twin-screw feeder is certified as OEB 5

In June, the newly developed, dust-tight OEB version of the DDSR20 2.0 twin-screw feeder (photo) passed the highest occupational exposure bands (OEB) classification certification, OEB 5. OEB classifications are used to grade substances accurately into “classes” or “ranges” based on the health effects and efficacy aspects of the chemicals involved. The DDSR20 2.0 OEB is suited for feeding requirements in pharmaceutical applications or handling of hazardous materials, for example in battery manufacturing. To provide dust-tight, reliable seals, all feeder seals feature specially designed sealing systems. The leak check opening in the twin gearbox is sealed with a sight glass to maintain functionality and to prevent ingredient leakage in the event of shaft-seal failure. — *Kubota Brabender Technologie GmbH, Duisburg, Germany*
www.brabender-technologie.com

Space-saving, efficient compressed-air production

With a minimal footprint of approximately 1 m^2, the compact Aircenter systems (photo) are available for flowrates from 0.34 to 2.7 m^3/min and also provide application-specific compressed-air treatment and storage. All Aircenter models are characterized by their exceptional efficiency. At the heart of the two largest models, the Aircenter 22 (11 kW) and the Aircenter 25 (15 kW), is an optimized SK series rotary screw compressor. With a maximum flowrate of 2.7 m^3/min, SK models deliver between 11 and 14% more compressed air, respectively, than their predecessors, the company says. This performance boost has been achieved both through airend optimization and the minimization of internal pressure losses. In turn, these improvements have led to a reduction in specific power of up to 5%. — *Kaeser Kompressoren SE, Coburg, Germany*
www.kaeser.com

This rupture disk improves process performance, efficiency

The technically advanced LoKr reverse rupture disk (photo, p. 19) delivers a best-in-class flow-resistance factor, K_R, to maximize pressure-relieving performance while delivering superior reliability and service life. The disk’s architecture has been re-

fined and optimized to improve performance in three key areas: keeping pressure drops in relief lines to an absolute minimum, providing maximum reliability and accuracy and being suitable for the widest range of pressures, temperatures and line sizes possible. The reverse-buckling disk combines a dimple on the disk with an innovative knuckle on the holder to offer full-bore opening with exceptionally accurate burst ratings. This enables a higher flowrate on burst than previously possible, demonstrated by the disk's low K_R value of 0.22. This makes it easier to keep pressure drops across the relief line below 3%, when the LoKr is used in relief valve isolation. Process plants can continue to use smaller piping diameters with no loss of performance or efficiency, even at low flowrates. — *OsecoElfab, Broken Arrow, Okla*.
www.osecoelfab.com

Sustainable water heater adds electric functionality

This company has launched updated GMP Water Heating Skids (photo) that incorporate the option to provide electrical heating utility in addition to steam and oil. The increased flexibility of the system enables its use in further GMP areas in the biopharmaceutical sector and other critical processing sectors. The company offers options to incorporate electrical heat pumps, regeneration and recovery heating to achieve corporate sustainability goals. With variable temperature settings up to 125°C and flowrates of 1,000 L/min or more, the versatile control system allows configuration of temperature controlled, regulated flowrate and pressure during heating, storing and distributing of hot water for process and utilities. Designed to comply with ASME BPE (Bioprocessing Equipment), they include compliance with the 2D dead-leg rule, full drainability, full traceability and are suitable for validation. — *Suncombe Ltd., Enfield, U.K.*
www.suncombe.com

Cool and dehumidify conveying air with this heat exchanger

This C Series heat exchanger (photo) replaced an older shell-and-tube design that had high operating costs, due to a 2.4 psi pressure drop. While both old and new units have the same capabilities, the new C Series pressure drop is only 0.1 psi. The lower pressure drop will save 50 hp in power, which translates into energy savings of about $50,000/yr. The housing is constructed from stainless steel. The unit will cool at a rate of 5,000 ft^3/min at 12 psi from 250°F to 65°F using 55°F cooling water. Features include a washable metal filter ahead of the cooling core, and an aluminum mist eliminator downstream that is removable and washable. The fin-tube core can be removed from the liquid-connection side of the housing for inspection without disassembling the gas duct. A variety of gas connection sizes and types are available. — *Xchanger, Hopkins, Minn.*
www.xchanger.com

New Delta Hybrid series

The Delta Hybrid series (photo) offers an innovative solution for the pneumatic conveying of sensitive, powdery and granular media. The rotary lobe compressors or screw blowers can offer maximum energy efficiency, minimum lifecycle costs, 100% pure and reliable process air and high durability even under extreme conditions. Now, the company has expanded the series with a new range of four package sizes. The new additions cover volume flows from approximately 2 to 30 m^3/min and drive powers from 7.5 to 55 kW and achieve enormous energy savings of up to 30% compared to a conventional positive displacement blower. Thanks to ATEX certification and hygienic design, the Delta Hybrid machines can be used without any problems in both highly critical, explosive and particularly hygiene-sensitive working environments — *Aerzener Maschinenfabrik GmbH, Aerzen, Germany*
www.aerzen.com

Wear-resistant screen cloth — with multiple service life

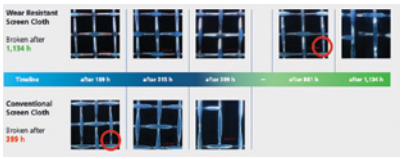
At Powtech last month, this company presented completely new, more wear-resistant screen cloths that, compared to previous standard cloths, achieve an increased service life with abrasive bulk mate-

OsecoElfab

Suncombe

Xchanger

Aerzener Maschinenfabrik

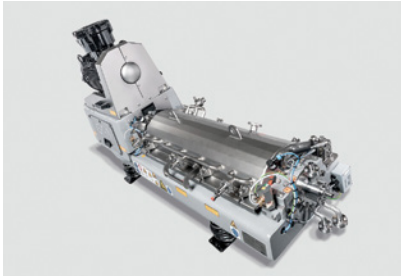


Allgaier Process Technology

Flowserve

Atlas Copco Compressors

Prominent



GEA Group

rials. Matched to the wire thickness and mesh size, the screen cloths are manufactured in a patented process, which significantly increases their wear resistance (photo). A particular advantage here is that, depending on the application, existing screening machines can also be equipped with these robust screen cloths. This innovation increases the plant availability of the users and reduces their downtime and maintenance costs. — *Allgaier Process Technology, Uhingen, Germany*
allgaier-process-technology.com

Isobaric energy recovery in desalination plants

The new FLEX isobaric energy recovery device (photo) is this company's next-generation compact pressure exchanger for reverse osmosis (RO) plants. The FLEX pressure exchanger is designed to be one of the most efficient and compact energy-recovery devices on the market. With its ability to recover more than 98% of hydraulic energy and offer the highest unit capacity available, while being notably smaller than competitor products, the FLEX pressure exchanger can substantially reduce the cost of desalination by lowering operating and capital expenditures, the company says. The FLEX offers a simple design with only four major internal components and is enabled for remote monitoring through the company's RedRaven IOT platform. — *Flowserve Corp., Dallas, Tex.*
www.flowserve.com

Next-generation compressor offers up to 60% energy savings

The GS variable-speed drive (VSD) compressor (photo) can adapt and optimize its operations, thanks to "smart" features. The GA VSDS (photo) is the third generation of VSD compressors. VSD compressors significantly reduce energy consumption by adjusting their motor speed to the fluctuations in compressed-air demand. The new technology will be available first in the 30–50 hp (22–37 kW) GA oil-injected screw compressor range. In addition to its minimal number of components, the GA VSD is the first compressor to feature an IE5 ferrite-assisted synchronous reluctance motor, eradicating the need for the use of increasingly precious and rare earth materials. — *Atlas Copco Compressors LLC, Rock Hill, S.C.*
www.atlascopco.com

New bypass armature for sensors in water treatment

The new Sensor Bypass Armature Modular (BAMa; photo) accommodates all potentiometric, amperometric and conductivity sensors from this company for water treatment. It is simply installed in a bypass of the main process line. The modules of the armature and the sensors can be removed and replaced without tools, for easy handling and cleaning. The sample-carrying components are designed so that suspensions with a solids content of up to 10% and particles up to 1 mm in diameter can flow through the armature. The material of construction is resistant to chemicals and can withstand temperatures up to 70°C and operating pressures of up to 7 bars. — *Prominent GmbH, Heidelberg, Germany*
www.prominent.com

New decanter for small production volumes, upscaling

The new pilotMaster (photo) is a robust two-phase separating decanter that is particularly suitable for smaller production volumes and for upscaling tests. Its geometries correspond to those of this company's large production machines. This ensures reliable upscaling and thus investment security. An optional ATEX design is also available. The pilotMaster has special protection against erosion and corrosion. All parts that come into contact with the product are made of high-alloy duplex steels, super duplex steels or Hastelloy C276. Depending on the application, the seals are made of NBR, FKM, FFKM or EPDM. The centrifuge offers maximum flexibility in bowl speed from 1,000 to 6,500 rpm, a differential speed range from 1 to 80 rpm without changing pulleys, and the same geometric configuration as the company's larger production machines. — *GEA Group, Düsseldorf, Germany*
www.gea.com

Gerald Ondrey

Critical Flanges: Advanced Washers Eliminate Galling and Hot Work

During vessel breakout activities, plants should pay close attention to the design of the washers used on bolted flanges. A simple change in this area can help to reduce downtime and improve safety

Lynnae Psimas, Ryder Britton and Shruti Bakshi
Integra Technologies

Bolted flanges on vessels, and their associated washers, are often seen as minor components in chemical processing facilities that may often be overlooked — until a critical problem arises. However, a closer examination of washer performance and design can help plants to significantly reduce maintenance time and costs, as well as improve operator safety. This article describes the real-world application of a new washer technology — the Velocity Washer — into a petrochemicals manufacturing plant.

The patented Velocity Washer (Figure 1) was developed to facilitate faster breakout times on critical flanges. Used on high-pressure, high-temperature industrial flanges in several industries, including petrochemicals, manufacturing and aerospace, the Velocity Washer reduces downtime and increases safety by eliminating galling, the primary source of seized fasteners.

Galling occurs when metal parts are slid past each other under high loads. During motion, local stress, adhesion deformation and heat can drive the formation of metallic bonds until the two separate pieces of equipment become one solid piece. Galling is extremely common, causing costly delays and requiring dangerous extraction efforts in plants. The Velocity Washer eliminates galling by removing the load on a nut before turning the bolt. This results in faster and more predictable breakout times and the elimination of hot work, reducing labor costs and increasing worker safety.

A new approach to washers

The Velocity Washer was recently introduced for a multinational petrochemical corporation to address issues related to galled or seized studs and nuts, production delays and hot work in a process area. The work site washes out three large fluidized-bed reactors every nine months to clear solids buildup. The site had a long history of costly delays and potentially hazardous remedies when trying to unbolt the minicones on the bottom of the reactors to perform said washouts. Prior to introducing Velocity Washers, removal of galled fasteners required torching off the nuts, which added 4–5 h to the washout procedure and involved the use of an open flame in a confined process area. This practice also introduced integrity concerns due to the presence of high temperatures close to the sealing surface of the flange.

FIGURE 1. The symmetrical design of these washers enables a simple installation in any orientation

The obvious safety issues, high cost and repeated production delays prompted the site to seek alternative solutions. Hydraulic torque tools were proposed, but when used, they were unable to break the galled nuts. This is because the phenomenon of galling is much more complex than simple high friction — it is a fusion of the two parts at a molecular level. High-temperature bolt lubricant also failed to reduce galling as it baked off at process temperatures. The senior maintenance team at the site also considered hydraulic nuts. However, consultation led integrity experts to suggest the Velocity Washer instead, due to its focus on galling, lower cost and simple installation.

The Velocity Washer uses a crenelated design (meaning it has intrinsic openings built in) consisting of two stacked pieces that are installed like a regular washer. Due to their symmetric design, they cannot be installed in the wrong direction. The nut is torqued into place using standard procedures, and the Velocity Washer remains in place throughout operation. At breakout, the nut is turned 12 deg to the left. The Velocity Washer pieces collapse, removing all load from the nut and preventing galling before it can start. The nut is then removed easily. Figure 2 illustrates these steps.

The petrochemical site's engineers placed the Velocity Washer on one minicone-shaped flange to test effec-

Integra Technologies

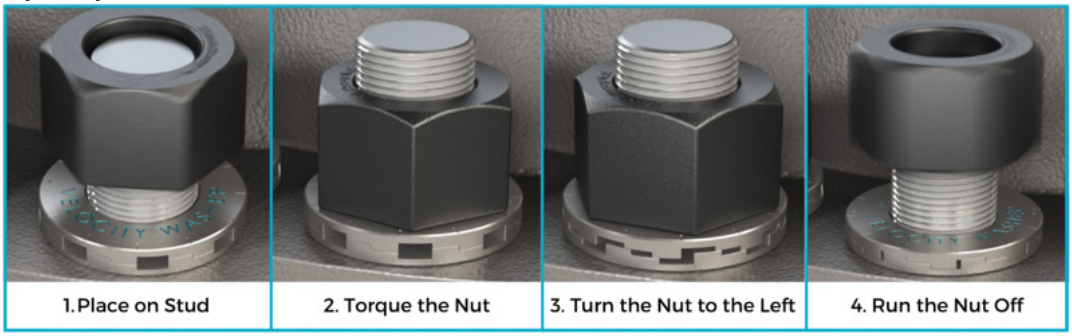


FIGURE 2. The setup procedure of these washers eliminates the risk of galling

tiveness. At washout, total breakout time was reduced to just over one hour, compared to as much as five hours previously.

All galling — and consequently all hot work — was eliminated. Following this favorable outcome, the site's maintenance team then installed the Velocity Washer on all minicone flanges. They also plan to install the Velocity Washer on other critical flanges as outages occur.

"We were skeptical that these would work because we weren't sure that galling was the issue. It felt like the nuts never moved 12 deg, but locked up immediately. We trialed them on the reactor, which for some reason, had the most issues. They worked great. We were able to break all the nuts without galling," explains one of the site's maintenance engineers. ■

Edited by Mary Page Bailey

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Polymer-based Piping Systems: Meeting the Challenges of the CPI

Due to favorable properties, such as light weight and corrosion resistance, plastic-piping systems are suitable for a growing number of applications

Thomas Küssner
GF Piping Systems

Over the past few decades, plastic-piping systems have been adopted in many different sectors of the chemical process industries (CPI). Advances in materials science have enabled polymer-based piping technology to meet even the uniquely stringent requirements of the chemical industry. When implemented correctly, plastic offers operators a highly efficient, cost-effective, and long-lasting solution for a wide range of applications.

As production processes in the CPI become more complex and demanding, operators require technology that helps them meet ever higher standards. Piping systems are essential to the safe and reliable transport of solids, liquids and gases. But in order to meet the challenges of the CPI, piping systems must fulfill three core requirements:

- High chemical compatibility to ensure that the pipe and the medium do not affect each other
- Components that have a long service life, to minimize downtime
- A system that is cost-effective and requires as little maintenance as possible

Plastic versus metal

Both metal and plastic piping systems have successfully established themselves in chemical plant construction. At the same time, though, the CPI presents such unique challenges that the choice of the correct material is essential to prevent unpredictable corrosion and therefore leakages or pipe bursts. For operators, this also means avoiding high maintenance costs, expensive production downtime and a preventable loss of valuable resources.

Polymer-based piping systems have become increasingly relevant for applications that transport, distribute, dose, or store liquid and gaseous media. Depending on the application, plastics can be a cost-effective alternative that offers high chemical resistance, as well as corrosion resistance. This is thanks to the adaptable compositions of modern plastics that reflect decades of experience in various chemical plants, knowledge on the effects of different ingredients on chemical resistance, and an understanding of their thermo-mechanical properties.

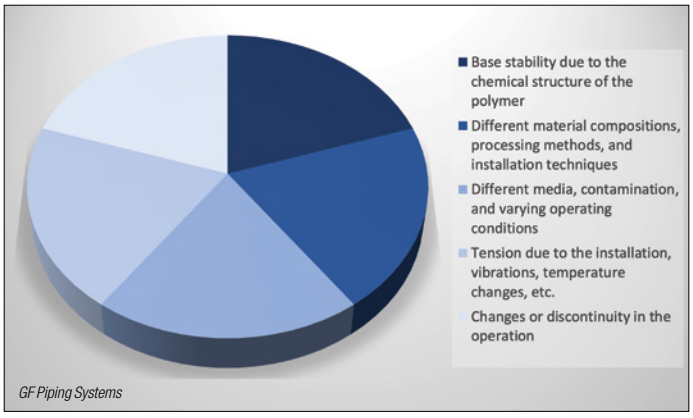

FIGURE 1. Chemical resistance is determined by various factors

Additionally, the corrosion resistance can also improve cost-effectiveness, since the long service life of plastic piping systems in many application scenarios (at least 25, and up to 100 years) limits the need for expensive maintenance or overhauls. A further relevant trait of plastics in the CPI is their thermal and electrical insulating properties. Finally, plastic piping systems are also up to 60% lighter than those made of traditional materials, which has advantages throughout their service life — from logistics all the way to installation and maintenance.

The right material for the job

While the material properties of plastic make it highly versatile, the choice of the correct piping material is imperative. Every CPI sector and every application has its unique set of requirements and challenges that have to be considered. Chemical resistance is determined by the properties of the base polymer, the material composition, and processing during the production phase (Figure 1). On-site, it is influenced by changing operating conditions and media, as well as mechanical tension. Similarly, corrosion also depends on a number of factors. These include the effects of the pipe on the medium and vice versa, permeation and diffusion into the polymer layer, as well as erosion during operation. All these factors must be considered during the planning phase.

However, many years of experience with plastics has led to an extensive understanding of their material compatibility, as well as their specific advantages within the CPI. Important fields of application have been the chlorine industry, surface industries (specializing in galvanization, for example), the pulp-and-paper sector or basic chemical synthesis.

The current state of research shows that polymer-based piping systems can transport practically every type of chemical at temperatures of up to 100°C and pressures up to 10 bars. Chemical resistance charts (Table 1), extensive national and international norms and regulations, as well as a close collaboration between operators and suppliers help to achieve the best results.

Sustainability

Global trends, such as digitalization, decarbonization and interest in the concept of a circular economy, have led to a paradigm shift in many industries. For suppliers of plastic-piping systems, the development of long-lasting and future-proof products is now a priority.

One immediate benefit of using plastic in the CPI is its often long operational lifetime, thanks to chemical and corrosion resistance. The possibility to keep the same piping system in operation for 25 years or more serves to save resources and reduce the amount of CO_2 emitted during production.

Methods of producing "greener" plastics are also becoming more widespread. Strict guidelines regulate additives and stipulate the parameters for the base polymers and manufacturing processes. Meanwhile, switching to renewable energy during the production of raw materials like resin can cut CO_2 emissions by up to 25%. And, in the case of polyvinylchloride (PVC) for example, the raw materials themselves can be improved upon: Instead of using a traditional ethylene based on crude oil, wood-waste from the paper industry that has been specially treated can serve as a sustainable alternative without impacting the material's quality. With bio-PVC, it is possible to reduce CO_2 emissions by as much as 90%.

Sustainability benefits can be quantified, as shown in the box that is included with the online version of this article (www.chemengonline.com), in which a lifecycle assessment was performed on a plastic valve and shows how this compares with one made of metal.

Pros and cons of plastics

While polymer-based solutions are the best choice for a number of applications, operators must consider the material's correct implementation. Know-how regarding materials such as metal is very common, but there are important differences that need to be considered before implementing polymer piping systems. As a result, every project phase needs to be rethought. Plastic is a more dynamic material and can contract and expand up to ten times faster than metal. It is also more susceptible to damage when installed incorrectly, for example due to overtightened metal clamps. At the same time, the low weight of plastic means that piping systems require less structural support on-site. In light of the different approach that plastic requires, many suppliers now offer specialized training and assist end-users beginning in the planning and engineering phase, which simplifies tasks such as selecting the right materials and calculating attachment points. Overall, polymer piping systems are the most versatile option for industrial plants, as they include many different pipe concepts, such as double containment, ventilation, hoses, standard thermoplastic pipes or pipe-in-pipe solutions. Some manufacturers of piping solutions also offer complete ecosystems comprised of a wide range of dimensions, pressure ratings, fittings and valve systems, as well as integrated technology for measurement and control.

To ensure a safe, leakage-free and maintenance-free service life in the challenging environments of the CPI, piping systems also need to be installed correctly. Here, plastic offers a wide range of jointing technologies for different types of polymers that ensure connections can last as long as the pipes themselves.

TABLE 1. CHEMICAL RESISTANCE

Chemical resistance at 20°C (Applications can be very dependent on the concentration)		Partially crystalline thermoplastics			Amorphous thermoplastics		Stainless steel	
Media	Chemicals	PE	PP	PVDF	PVC-U	PVC-C	1.4401 316	1.4301 304
Oxidizing Acids (HNO_3, H_2CrO_4, H_2SO_4, and so on)	$HNO_3 \leq 25\%$	o	o	+	+	+	o	o
	$25\% \leq HNO_3 \leq 65\%$	o	-	+	o	+	o	o
	H_2CrO_4 aqueous solution	o	o	+	o	o	o	o
	$H_2SO_4 \leq 70\%$	+	+	+	+	+	-	-
	$70\% \leq H_2SO_4 \leq 96\%$	-	-	+	+	+	-	-
Non Oxidizing Acids (HCL, HF and so on)	$HCl \leq 30\%$	+	+	+	+	+	o	-
	$HF \leq 40\%$	+	+	+	+	-	o	-
	$40\% \leq HF \leq 75\%$	+	+	+	-	-	-	-
Organic (formic acid, acetic acid, citric acid and so on)	$HCOOH \leq 25\%$	+	+	+	+	+	o	-
	$25\% \leq HCOOH \leq$ tech. pure	+	+	+	+	-	o	-
	$CH_3COOH \leq 50\%$	+	+	+	+	+	o	-
	$50\% \leq CH_3COOH \leq$ tech. pure	+	+	+	o	-	o	-
	$C_3H_4OH(COOH)_3$	+	+	+	+	+	o	-
Bases	Inorganic (NaOH, KOH, others)	+	+	-	+	o	+	+
	Organic (amine, imidazole, etc.)	+	+	-	o	-	o	o
Salts	NaCl, $FeCl_2$, $FeCl_3$, $CaCl_2$, others	+	+	+	+	+	o	o
Halogens	Chlorine, bromine, iodine, (no fluorine)	-	-	o	o	o	o	-
Fuels/Oils	Aliphatic hydrocarbons	o	o	+	+	o	+	+
	Aromatic hydrocarbons	-	-	+	-	-	+	+
Solvents	Chlorinated hydrocarbons	-	-	o	-	-	o	o
	Ketones	+	+	o	-	-	+	+
	Alcohols	+	+	+	o	-	+	+
	Esters	o	o	o	-	-	+	+
	Aldehydes	+	+	-	-	-	+	+
Phenols	Phenol, Cresol,and others	+	+	+	-	-	+	-

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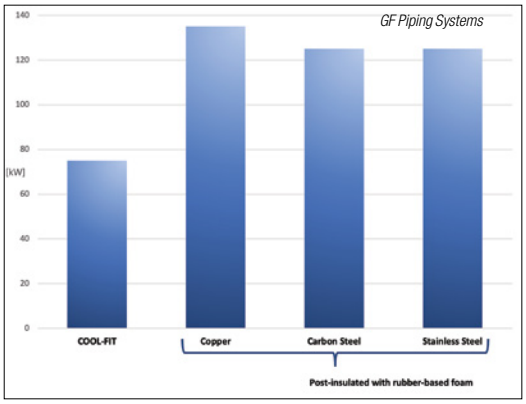

FIGURE 2. This chart shows the energy efficiency of a pre-insulated plastic-piping system compared to post-insulated materials

When deciding on a jointing method, the most important factors are cost-effectiveness, the type of piping components, the internal and external influences on the system, and the type of medium. Tools for processes like butt welding or electrofusion are easy to use and produce reliable results. Moreover, advances in technology now permit infrared (IR) welding for thermoplastic piping systems, which reduces the buildup of welding stress and results in smaller welding beads. IR welding aids installers with automated processes and supports the creation of welds that are both documented and reproducible. This type of welding is also especially relevant for the CPI. By eliminating the issue of molecules escaping from the solvent used for adhesive pipe connections, it makes plastic piping ideal for ultrapure applications.

Additionally, specialized solutions, such as non-destructive testing (NDT), can give operators peace of mind by verifying the quality of pipe connections. This is an established process for metal piping systems that has recently also been developed specifically for plastic piping systems. By transmitting high-frequency ultrasonic waves through welds, it is possible to detect flaws within. Algorithms developed from large sets of historical data quickly provide a pass/fail rating for each weld before the pipe goes into operation. Ultrasonic NDT therefore adds a layer of safety for the chemical process and further increases the reliability of plastic piping systems.

Examples of applications

In closing, we present two actual case studies of the adoption of plastic piping systems.

Unimicron Germany implements plastic piping solutions. Water plays an important role in the CPI. Pure and ultra-pure water are indispensable for the manufacturing of many products. However, this has also had social consequences, as the industry traditionally used large amounts of this valuable resource and often obtained it directly from nature. Many companies now prefer to adopt a more sustainable approach, based on the use of closed loops and modern piping systems. Unimicron Germany GmbH (Geldern, Germany) is one of those companies. The circuit board expert serves sectors such as the automobile industry, medical technology and renewable energy. And, thanks to automation, the company has Europe's most modern circuit-board manufacturing facility. Unimicron Germany maintains high standards not only when it comes to the quality of their end products, but also with regard to sustainability. The company keeps its process water in a closed loop and purifies it after each use to save resources.

In order to make the closed loop as efficient and safe as possible, Unimicron Germany relies on plastic piping systems. For circuit board manufacturing, it is important that the piping systems for process water do not introduce any impurities and are cavity-free to ensure optimal flow and prevent deposits. Unimicron therefore implements a complete solution consisting of polypropylene and PVC-U pipes, fittings and valves.

Thanks to an array of sensors, controllers and transmitters, it is possible to monitor parameters such as flow, pressure, pH values or the amount of oxygen and chlorine in the process water. This digital ecosystem allows Unimicron Germany to easily monitor and control their water cycle, while the choice of materials ensures a long and reliable service life without interruptions. The result is a high-quality and hygienic water treatment that does not compromise on quality.

Pre-insulated plastic piping systems at West Pharmaceutical Services. The production facility at West Pharmaceutical Services GmbH & Co. KG (Stolberg, Germany) runs at capacity at all times. The company specializes in rubber seals for medical devices, such as syringes, intravenous (IV) drips or pipettes, and produces them with injection-molding machines in a clean-room atmosphere. When running continuously, these machines require large amounts of cooling water to prevent overheating. In need of a durable cooling system, West Pharmaceutical Services selected a commercial plastic-piping system.

This system is a pre-insulated three-in-one piping system for chilled water, and is designed as a corrosion- and condensation-free solution for applications, such as process cooling. Thanks to the low thermal conductivity of PE100 and its foam-based insulation, the system is 30% more energy efficient than comparable metal systems (Figure 2). Furthermore, the system can be installed 50% faster due to the pre-insulation of the components and the electrofusion jointing technology.

West Pharmaceutical Services decided to increase the cooling capacity of its facility and increased the dimensions of its piping from DN50 to DN80. With the stripping and peeling tool, the installers are able to simultaneously remove the oxide layer from the pipes, as well as the insulation in the necessary insertion depth. The pipes are then connected through electrofusion with an integrated data logging function. The installation is carried out within three weeks thanks to the prefabricated components. This not only simplifies the installation but also prevents long downtimes caused by heavy metal components and a post-insulation process. The plastic-based system offers West Pharmaceutical Services a durable system that is capable of efficiently cooling the production of medical devices 24/7 for many years to come. ■

Edited by Gerald Ondrey

Author

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Crossflow Membrane Filtration Module Types

Department Editor: Scott Jenkins

In crossflow membrane filtration (CMF), feed flow is parallel to the filtration surface (rather than perpendicular to it, as in conventional filtration). During a given pass, a portion of the feed permeates the membrane, while a larger portion is retained as retentate. Most of the retentate is returned for multiple passes, by a circulation pump. CMF is common across many industry sectors, and applications and offers advantages in its ability to impart shear onto the filtration surface. This reduces fouling by particulate matter or retained molecules. Several module configurations and membrane types are available. This one-page reference reviews common filter-module configurations and membrane materials.

Membrane materials

Modern CMF membrane materials include polysulfone (PS), polyethersulfone (PES), polyvinylidene fluoride (PVDF), polyacrylonitrile (PAN), polyamides, polytetrafluoroethylene (PTFE) and polypropylene (PP).

Most CMF membranes are asymmetric, with a thin selective layer on top of a more open support layer. The tight selective layer does the actual filtration, while the open support layer minimizes resistance to flow and provides mechanical integrity.

Inorganic membranes include ceramics, such as α-alumina, zirconia and metal oxides (notably, titanium dioxide), sintered stainless steel and graphite. More robust than most polymers, inorganic membranes can withstand strong acids and bases, as well as high temperatures and pressures. Such membranes are particularly useful for high-fouling applications that require aggressive cleaning.

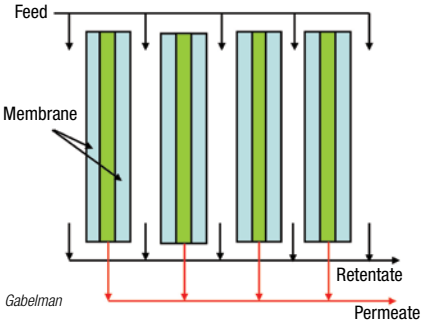

FIGURE 2. In plate-and-frame modules, the space between opposite sides provides a flow path for permeate

Module configurations

Available CMF module configurations are described here.

Hollow fiber. This module contains a bundle of polymeric tubes (hollow fibers), potted at both ends and encased in a shell. The geometry is analogous to that of a shell-and-tube heat exchanger, and the tube wall is the membrane. Feed enters the tubes at the bottom, retentate leaves at the top, and permeate passes through the tube walls, then exits through the shell side. A typical module is 10–20 cm in diameter by 1–1.6 m in length. The main advantage of the hollow-fiber configuration is the ability to tightly pack the fibers, allowing a high membrane area per unit volume (as high as 16,000 m^2/m^3). Another advantage is the ability to backwash for more effective cleaning.

Spiral wound. This design consists of membrane envelopes wound around a perforated central core. Each envelope contains two rectangular membrane sheets facing away from each other, separated by a porous spacer. These spaces provide a path for the permeate, which flows around the spiral to the central core, then exits the module. The spaces between adjacent envelopes, separated by grids, serve as flow channels for the feed and retentate. Each envelope is sealed with adhesive on three sides, and the fourth side is attached to the central tube. Typical channel width, module diameter and length are 0.25–0.5 mm, 10–40 cm and 1–1.5 m, respectively. Spiral-wound modules are commonly used for water purification. Advantages are lower energy consumption compared to other designs, and high area per unit volume. Spiral-wound units are not suitable if fibrous solids are present, because these will clog the grids.

Tubular. Like the hollow-fiber design, tubular modules have a shell-and-tube geometry, but the tubes are larger, with the inner diameter ranging from 2.5 to 25 mm (Figure 1). The tubes consist of a porous support, such as fiberglass-reinforced epoxy, with the active layer formed on the inside surface. The shell is made from stainless steel or a hard polymer. Tubular modules are chosen for difficult-to-handle feeds that are not suitable for hollow-fiber or spiral-wound designs. These include high-viscosity feeds and those with high undissolved solids content, large particles, or highly compressible or gelatinous solids. In addition to handling challenging streams, other advantages of tubular design include high resistance to fouling and ease of cleaning. Disadvantages are low packing density; high energy consumption; and the inability to backwash. Applications include wastewater treatment, paint recovery and juice clarification.


Courtesy of Koch Membrane Systems Inc.

FIGURE 1. Tubular modules are useful for difficult-to-handle feeds

Plate-and-frame. These modules contain a series of flat membrane sheets arranged in a plate-and-frame assembly. The membrane side of each sheet faces a feed channel, with the space between the opposite sides providing a flow path for permeate. This assembly, reminiscent of a traditional filter press, is situated between two end plates, with gaskets placed as needed to direct flow (Figure 2).

Ceramics. A ceramic module consists of a porous ceramic material, called a monolith, through which parallel flow channels have been formed. The separation is performed by a thin active layer of smaller particles deposited onto the inside surface of the channels. The active layer is usually α-alumina, zirconia or titanium dioxide, while the monolith is typically α-alumina or other metal oxide. ■

Editor's note: This material was adapted from the following article: Gabelman, A., Crossflow Membrane Filtration Essentials, *Chem. Eng.*, April 2017, pp. 49–59.

Managing Fouling in Heat Exchangers

Fouling of heat exchanger surfaces reduces thermal efficiency. An improved understanding of fouling and the design factors that affect it can help ensure that heat exchange occurs during normal operating conditions

Matt Hale
HRS Heat Exchangers

IN BRIEF

Using tubular heat exchangers is an efficient and reliable method of transferring heat from one material or product to another. However, by their nature, some materials can result in fouling of the surfaces of any heat exchanger, which reduces thermal efficiency. This is particularly true when heat exchangers are used in exceptionally challenging conditions, or are used for difficult materials, such as sewage and wastewater sludges.

Understanding both fluid dynamics and the different types of fouling that can occur helps heat-exchanger designers and engineers to create systems that can withstand fouling and allows them to specify the best equipment for a particular situation or material. The impact of fouling in heat exchangers has been recognized for more than a century, but in recent years, there have been many developments in equipment and practice. This includes patented designs and standard good practices, such as maintaining flowrates and carefully controlling temperatures. The best heat-exchanger designs take into account the standard "fouling factors" for the process and product at the specification stage, as well as knowledge of actual product fouling behavior, ensuring that sufficient heat exchange occurs when normal levels of fouling are experienced in operation.

Fouling impact

Fouling is generally defined as the deposition and accumulation of unwanted material, such as scale, suspended solids, insoluble salts and even algae, on the internal surfaces of the heat exchanger. Fouling occurs when fluids degrade near the tube wall and layers of solids are deposited onto the tube wall. These layers of material act as an insulator and prevent effective heat transfer. Depending on the materials involved, this fouling can occur on both the primary and service surfaces of the exchanger, and sometimes both at once.

In general, the more viscous the fluid, the lower the heat-transfer rate, so very viscous fluids require very large heat-transfer areas. Scraped-surface heat exchangers mix the fluid, which increases the amount of fluid coming into contact with the heat-exchange surface (Figure 1). This reduces fouling rates while increasing the heat-transfer rates. In some cases, it also reduces the surface area required.

Fouling has a significant impact on heat transfer across the heat-exchanger surface, and therefore on the overall operational performance. Ultimately, the impact is observed on the economics of the process. In extreme cases, the build-up of fouling materials also reduces the cross-sectional area of the tubes or flow channels in the heat exchanger and increases the resistance of the fluid(s) passing over the surface. These additional effects combine to increase the pressure drop across the heat exchanger, reducing flowrates and aggravating the problem further.

Some fouling deposits can lead to corrosion of the heat exchanger (which can be hidden by the fouling layer itself), shortening the working life of the heat exchanger or causing catastrophic failure during operation.

FIGURE 1. For materials with high fouling potential, a scraped-surface heat exchanger may be required

FIGURE 2. Biological fouling from algae can often be encountered where river water is used for cooling

Modeling fouling

During planning, engineers use a fouling factor and process experience to model how fouling may affect the performance of a heat exchanger. The fouling factor represents the theoretical resistance to heat flow due to the buildup of a fouling layer on the tube surfaces of the heat exchanger. In practice, fouling factors are often overstated by the end user in an attempt to minimize the frequency of cleaning. In reality however, using the wrong fouling factor may actually result in the need for more frequent cleaning.

The fouling factor is a mathematical value (usually referred to as *Rf* or *Rd*) that represents the thermal resistance of the deposits and is effectively a ratio between the transfer coefficient of a clean heat exchanger and the same unit after fouling. Standard fouling-factor values are available for a number of common liquids and gases, such as fuel oil, seawater and alcohol vapor. However, for many materials, including those with the highest fouling factors, such as sludges, it is best to analyze the substance in order to achieve an accurate result.

Fouling in practice

One of the first signs of significant fouling beyond design parameters is a loss of heat-exchanger performance as heat transfer across the exchanger deteriorates. Users will also sometimes see an increase in the pressure drop as fouling builds up, but this is an unreliable indicator of heat-exchanger performance.

There are different types of fouling, and sometimes different terms are used for different types of fouling, leading to potential confusion about what is actually happening in a particular situation.

The four different categories of fouling are the following:

- Chemical fouling, also known as scaling, occurs when chemical changes within the fluid cause a fouling layer to be deposited onto the surface of the exchanger tube
- Biological fouling (Figure 2) is caused by the growth of organisms, such as algae, which deposit onto the surfaces of the heat exchanger. While outside the direct control of heat-exchanger designers, it can be sometimes be influenced by the choice of construction material
- Deposition fouling (often denaturation or sedimentation fouling), occurs when particles contained within the fluid settle out onto the surface, usually when the product burns on the tube wall or the fluid's velocity falls below a critical level
- Corrosion fouling (Figure 3) occurs when a layer of corrosion products builds up on the tube surface. This forms an extra layer of material, which often has thermal resistance. Corrosion fouling should not be confused with corrosion occurring under the fouling layer, as mentioned previously

Chemical fouling

Within the four categories outlined above, there are different specific examples, each of which will manifest itself in slightly different ways or under different circumstances, and each of which is prevented or treated in a different manner.

Scaling (including limescale). Limescale is the most familiar chemical fouling agent. For many of us it builds up in our kettles and pipework at home. In industrial applications, scaling is particularly problematic when cooling water has a high mineral content.

Symptoms of scaling are the classic "limescale" buildup inside the heat exchanger (and usually also building up throughout the whole water line, including pipes and pumps), although local factors and different minerals will result in a different appearance. Prevention takes the form of chemical dosing of the water (for example, with salt or acid for "hard" water), and chemical agents are required for cleaning or removal.

Struvite. Struvite (magnesium ammonium phosphate) is a phosphate mineral that often precipitates in urine (Figure 4). It is the same material that forms kidney stones, particularly in humans and animals that have plant-based diets (which are high in magnesium) or are infected with ammonia-producing organisms.

Struvite can be a particular problem in sewage and wastewater treatment, especially in systems that include anaerobic digestion, because that process releases ammonium and phosphate. Struvite forms a hard scale on many surfaces, including inside pipes and heat exchangers.

The same considerations that apply to chemical fouling and scaling also apply to preventing struvite formation in heat exchangers. Keeping water temperatures below 65°C will help prevent struvite formation, as will restricting the amount of phosphorus added to the digester. Struvite can often be physically removed, and because struvite is a valuable mineral, many wastewater plants and businesses are looking into commercial struvite recovery.

Vivianite. Vivianite (ferrous phosphate) is a particular problem where ferric chloride (also known as pickle liquor) is added to sludge to control hydrogen sulfide (H_2S) emissions. Where water temperatures are too high, this can lead to the deposition of a hard blue-green material (vivianite) on the heat exchanger surface.

As with struvite, keeping water temperatures below 65°C will help prevent vivianite formation, as will carefully controlling the chemicals

FIGURE 3. Corrosion fouling, such as the fouling shown here, usually occurs under specific circumstances

FIGURE 4. Struvite (magnesium ammonium phosphate) is one of the most commonly encountered fouling agents. Companies, such as Ostara, recover it as a valuable nutrient for reuse

added to the sludge stream, although this is usually determined by other factors. Cleaning is very difficult, often relying on the use of hydrochloric acid solutions which may not be compatible with the materials used in heat exchanger and system construction.

Biological fouling

Living organisms can also cause fouling when untreated water is used.

Algae. Algal fouling is particularly encountered where untreated river or canal water is used for cooling. Environmental regulations prevent the use of chemical additives and also limit the temperature increase and so algae quickly grow in what is an ideal environment.

Using high velocities or even scraped-surface heat exchangers can prevent fouling, as can the use of construction materials such as copper or brass. A regular cleaning regime is usually necessary.

Zebra mussels. Zebra mussels are an invasive species found across the world. They are now established in freshwater bodies in the Southeast of England and are found in sewers and sewage-treatment works. They enter pipework as larvae and then colonize and grow. In the worst cases, hundreds of tons of mussels have been removed from some water-treatment works. They are relatively uncommon in heat exchangers and can be controlled by keeping the velocity of the fluid through the exchanger above 2 m/s to prevent larvae attaching.

Final filtered effluent. In some wastewater-treatment sites, final filtered effluent (FFE) taken after the filter press is used as a free cooling medium. Due to the high level of biological material contained in FFE, it has a high fouling potential and fouling can quickly occur, depending on the exact nature of both the FFE and the heat exchanger design.

Ultraviolet (UV) radiation treatment of the FFE can sometimes help to reduce the biological load, and therefore the potential for fouling, but it is expensive and not 100% effective. These systems are normally left to run, then are cleaned when necessary, with cleaning usually relying on caustic cleaning-in-place (CIP) systems. It is therefore important to specify heat exchangers and other equipment that can cope with such caustic cleaning materials.

Deposition fouling

Solid particles in the media settling onto the heat-exchange surface is deposition fouling.

Sediment. This is the most common type of heat-exchanger fouling and is caused by particulate matter in the treated fluid settling out onto the surface of the heat exchanger.

It will usually be prevented by good heat-exchanger design and choosing the right heat exchanger for the job. For example, making sure that the fluid has sufficient velocity, while the use of corrugated tubes can prevent sedimentation, or scraped-surface heat exchangers can continually remove it to ensure efficient operation.

Burn-on. Burn-on occurs where the heat exchanger wall temperature is too high, causing particles in the fluid (particularly organic materials) to become baked onto the tube walls. It often occurs where a malfunction has arisen; for example, heating has continued while product flow has stopped, resulting in overheating of the material.

The likelihood of burn-on can be reduced by good design of the overall system and interlocking the controls for both water and sludge pumps, so that if one stops, so does the other one. Control of the water temperature (ideally keeping it below 90°C) will also help prevent burn-on. Where it occurs, it can usually be removed by physical or chemical cleaning.

Corrosion fouling. This type of fouling usually occurs in specific circumstances where either the material being treated, or the construction of the heat exchanger itself, is particularly susceptible to corrosion. For example, aluminum and copper can be highly reactive and frequently suffer from galvanic corrosion, or the formation of oxides on the tube surface where they have been used for the manufacture of heat-exchanger tubes.

Using a material that is resistant to such corrosion, yet maintains good thermal-transfer properties, such as stainless steel, will overcome most of these issues. Good system design (for example, to regularly remove grit) and regular cleaning will also help to prevent the formation of corrosion.

Another form of corrosion fouling is crystallization where, due to cooling or increasing concentration, components in the fluid are deposited on the heat-exchanger surface. Scraping the heat-transfer surface to remove these layers of fouling maintains high heat-transfer rates in such situations.

Preventing fouling

As in many aspects of life, prevention is better than cure. Preventing or reducing fouling is less expensive and more effective in maintaining heat-exchanger performance than cleaning or removing fouling that has already occurred.

Two of the main methods for preventing fouling are material choice and heat-exchanger design. The surface of the heat exchanger will have an effect on fouling, and rough surfaces are known to collect particulate matter (which increases fouling). The smooth, polished surfaces that can be achieved on tubes made from 304 or 316 stainless steel therefore help to minimize fouling.

Using corrugated tubes in heat-exchanger construction is beneficial in increasing heat transfer and

FIGURE 5. Some scraped-surface heat exchangers use a rotating or helical scraper bar, like the one shown here

preventing deposition fouling. As an alternative to corrugated-tube heat exchangers, some situations may require the use of scraped-surface heat exchangers (Figures 1 and 5, which are used in cases where fouling would otherwise cause heat transfer rates to drop, or when viscous fluids have very low heat-transfer rates.

Cleaning of fouling

In some applications, no matter how well you design the system, fouling will occur in the heat exchangers, pumps and pipework. In this case, its advisable to have a fast and efficient local cleaning system, and there are a number of lessons learned from other industries. In food processing, inline cleaning at the end of every shift is very common using clean-In-place (CIP) systems. These are often standalone systems that automatically flush and chemically clean the equipment. Then, the system flushes away the cleaning chemicals before putting the plant back into operation. CIP systems typically use multiple caustic and acid washes, and are specifically designed for the process and type of fouling expected.

Exchanger calculations

In order to determine the best type of heat exchanger for a particular role and ensure that the heat exchanger has sufficient heat-transfer area for the materials involved, a number of calculations are required. Whole books have been written on the thermodynamics and science of heat transfer, but the basic heat design equation for simple fluids is shown in Equation (1).

$$Q = U\,A\,\Delta T_{lm} \quad \textbf{(1)}$$

where: Q is the rate of heat transfer between the two fluids in the heat exchanger. U is the overall heat transfer coefficient, which depends on the conductive properties of the fluids and the heat exchanger material. A is the heat-transfer surface area. ΔT_{lm} is the log mean temperature difference, calculated from the inlet and outlet temperatures of both fluids.

The value of U is harder to calculate:

$$U = 1/(1/h_1 + R_{f1} + R_W + 1/h_2 + R_{f2}) \quad \textbf{(2)}$$

where: h_1 and h_2 are the partial heat-transfer coefficients, watts per square meter Kelvin, W/m^2·K (tube and shell side)

R_w is the thermal resistance of the wall, m^2·K/W

R_{f1} and R_{f2} are the fouling factors, m^2·K/W (tube and shell side)

While the values for R_f are usually specified by the client, the values of h and R_w can be influenced directly by the designer depending on the choice of tube size and thickness, and the materials used for construction. The values of the partial heat-transfer coefficients h depend greatly on the nature of the fluids but also, crucially, on the geometry of the heat-transfer surfaces with which they are in contact. Importantly, the final values are heavily influenced by what happens at the level of the boundary layers. The boundary layer is the fluid actually in contact with the heat-transfer surface.

Laminar and turbulent flow

One of the reasons for making corrugated-tube and scraped-surface heat exchangers is that they are required for fluids and materials with complex properties, such as viscous and non-Newtonian fluids, or materials containing solid particles.

One of the important factors controlling heat transfer is the resistance to heat flow through the various "layers" that form a barrier between the two fluids. There are effectively five of these layers that add resistance to the heat flow between the two fluids in the heat exchanger.

1. The inside "boundary layer" formed by the fluid flowing in close contact with the inside surface of the tube
2. The fouling layer formed by deposition of solids or semi-solids onto the inside surface of the tube (the fouling layer may or may not be present)
3. The thickness of the tube wall and the material used, which will govern the resistance to heat flow though the tube itself
4. The fouling layer formed by deposition of solids or semi-solids on the outside surface of the tube (which may or may not be present)
5. The outside "boundary layer" formed by the fluid flowing in close contact with the outside surface of the tube

The values used for items 2 and 4 can usually be supplied by the client, while the designer of the heat exchanger will select the tube size, thickness and materials to suit the application. The resistance to heat flow resulting from numbers 1 and 5, (known as the partial heat-transfer coefficients) depends both on the nature of the fluids and on the geometry of the heat-transfer surfaces themselves.

One way to prevent the build-up of these layers (and therefore to reduce the potential for fouling) in certain fluids is to increase the speed at which they pass through the heat exchanger so that turbulence is created and the boundary layer breaks away from the surface of the tube. This is the point at which so-called laminar flow (with the fluid passing through smooth layers, where the innermost layer flows at a higher rate than the outermost) becomes turbulent flow (where fluid does not flow in smooth layers, but is mixed or agitated as it flows).

The velocity at which this occurs is influenced by many different factors, but in order to quantify it for the purposes of specifying heat-exchanger properties, engineers use the Reynolds number.

Reynolds number

The Reynolds number is denoted by Re and represents (*Inertial force*)/(*Viscous force*). It is calculated using Equation (3).

$$Re = \rho VL/\mu \quad \textbf{(3)}$$

where: ρ is the density of the fluid, V is the velocity of the fluid, L is the length or diameter of the fluid and μ is the viscosity of the fluid.

Reynolds numbers of less than 2,000 describe laminar flow, while numbers above 10,000 describe turbulent flows. At values between 2,000 and 10,000, there is a zone of uncertainty called the transitional zone, where there may or may not be turbulence generated depending on other unpredictable factors.

The corrugation of the inner tubes significantly increases the rates of heat transfer in the transition- and turbulent-flow areas. Under the right circumstances, the amount of heat transfer can be doubled, which means a 50% reduction of heat-transfer energy requirements, a significant cost saving.

Concluding remarks

Heat-exchanger fouling (and its prevention) is actually far more complicated than it may seem at first glance. While some forms of fouling are unavoidable, careful design and choice of the right heat exchanger, for example using corrugated tubes, can go a long way to minimizing the effects. The first step should always be to analyze both the product and service fluids in order to calculate accurate fouling factors. This is followed by good design to ensure adequate fluid velocities, temperatures and other operating parameters.

Heat exchanger designers and engineers will use a combination of materials analysis and the calculated fouling factor to ensure that the heat exchanger recommended for a particular purpose not only resists fouling for as long as possible, but that if fouling does occur, it can be cleaned and dealt with efficiently and effectively. For example, this could involve making the required frequency of inspection and cleaning as quick and simple as possible, with features such as integrated inspection panels and removable tubes. ■

Edited by Scott Jenkins

All photos courtesy of HRS Heat Exchangers Inc.

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Valves: Essential Workhorses

Concise tips on selecting the right valve

Don Bowers
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A typical chemical plant contains miles of piping and hundreds, if not thousands, of industrial valves (Figure 1) that are essential for the plant to operate efficiently and safely. Unlike the simple consumer valves that are used to regulate water flow in your sink, shower or bathtub, industrial valves for chemical plants must be designed, manufactured, tested and maintained for reliable operation in rugged applications. For many applications, valves installed in chemical plants must be of the "severe service," high-performance type.

Chemical plants are hostile environments with many kinds of hazardous acids, corrosive media and extreme pressures and temperatures. Reliable valves are essential to isolate equipment, control the flow of process liquids and gases, and provide reliable venting, draining and over-pressure protection.

Valves play a major role in assuring the safety of property, personnel and the public by preventing or minimizing harmful leaks, fires and, in extreme cases, explosions. Specifiers of valves for chemical plants have a serious responsibility to make sure that they select the right valve for the right application. The negative consequences of mistakes or errors in calculations can be serious and hugely expensive.

Cost considerations

In new construction, it is essential to avoid the temptation to specify lower-cost valves because the downside can be significant. The initial cost may be lower, but as time goes by, plant operators will pay a price (total cost of ownership) in terms of shorter life cycle, leakage, forced shutdowns, repairs, replacements and potential accidents.

The price differential between a low-cost valve and a quality valve may be as much as 25–40%, which may seem like a lot percentage-wise, but in real dollars, it is not. For example, if you have a choice between a $1,000 high-quality valve and a $600 low-cost valve, the savings achieved by installing a low-cost valve appear to be $400. Compare that with the cost of prematurely replacing a low-cost valve with a higher-quality valve. If you add up the replacement valve cost, labor cost, welding, post-weld heat treatment (PWHT) and non-destructive evaluation (NDE) costs and shutdown cost, just one valve replacement can easily cost $10,000 or more.


Shutterstock

FIGURE 1. A typical plant in the chemical process industries will have hundreds of valves

Part of the problem is that the engineering, procurement and construction (EPC) company that saves the $400 on the front end is typically not responsible for the resulting $10,000 expense incurred by the plant owner/operator during plant operation. When viewed from this perspective, installing the valve that provides the best value the first time serves the best interests of all entities involved.

Another problem with installing low cost valves on the front end is that these suppliers may not have a defined presence in supplying for maintenance, repair and overhaul (MRO) opportunities.

For most applications, any valve will eventually require repair or replacement. Therefore, it makes sense to specify quality valves that are easy and economical to inspect, repair or replace. Wherever possible, in-line serviceability is a significant advantage because you do not have to cut and re-weld connecting piping.

Since an increasing number of valves are being actuated and integrated into distributed control systems (DCS) to enhance real-time plant monitoring and improve plant efficiency, specifying longer-life, higher-quality valves will maximize the plant operator's investment in these expensive, networked systems.

The valve selection process

When assessing which valves are best for each operation in a chemical plant, there are no quick short-cuts. You need to spend an appropriate amount of "think time," aided by state-of-the-art software and computerized simulations, to make sure that every step in the controlled flow of liquids and gases is fully understood and taken into account.

Questions to ask. Key factors to consider can be addressed by asking the following questions:

- Can the valve "go with the flow?" Can the valve accurately and reliably handle the flowrate (C_V)?
- Is the valve in-line repairable?
- Are the materials of construction suitable for the intended application as a function of mitigating the effects of a corrosive media and fluids containing particulate matter that are abrasive (erosion)?
- Is the valve manufacturer and its sales channel active in supporting your plant once the valve is installed?
- Can the valve provide reliable, tight, leak-free shut-off at the intended pressures?
- Is the valve "pressure sensitive?" Has it been designed and properly specified to handle the pressures and temperatures for the applications in which it will be installed?

("Tight is might")

- Can the valve be delivered to meet plant need dates?
- Does the valve meet applicable codes and standards imposed by federal, state, province or other jurisdictional requirements?

Pick the brains of manufacturers. As you evaluate your valve needs, don't forget to tap into the wisdom and experience of established, reputable severe-service valve manufacturers and their authorized representatives. They have a wealth of understanding and knowledge that you can leverage to help you to make the wisest valve specification decisions.

Always adhere to standards. In all cases, careful specification of valves that meet applicable codes and standards is required. Determination that your valve supplier can meet these standards can be made by review of their catalog information, their websites or by audit. Note that these criteria can differ from state to state, province to province or nation to nation, so you will need to determine applicability accordingly. Common codes and standards include those published by the American Society of Mechanical Engineers (ASME), the American Petroleum Institute (API), the Manufacturers Standardization Society (MSS), the International Organization for Standardization (ISO), ASTM International, the American National Standards Institute (ANSI), the American Waterworks Association (AWWA) and the Instrument Society of America (ISA).

An example

Over a number of years, experience has revealed that, sometimes individually and sometimes working in tandem, misapplication or purchasing based on price versus required design features can provide poor results for valves in severe-service applications. This can happen both at the project purchasing level, as well as the MRO purchasing level.

A recent example involved a plant owner employing carbon dioxide sequestration in the manufacturing process. This plant was experiencing premature seat leakage, resulting in solidification of the process media, loss of CO_2 and subsequent shutdown of the line, significantly impacting both cost and schedule. In some instances, this occurred only weeks after the original valve was installed. Working with a more experienced valve manufacturer, the root cause was determined and the valves were replaced with suitable alternatives that eliminated the problem. These valves have now been working for almost two years without a failure, and the owner has replaced all the original valves, resulting in significant savings in repairs, replacement valves/parts, and process downtime.

Final remarks

The reality of project purchasing, where an owner selects an EPC organization based on a fixed price estimate that the EPC submits for a scope of work (for example, a power plant) can result in the potential that the owner will have to deal with products that the EPC supplies that only marginally meet specification requirements. Because of this, the competitive nature of the bidding process drives a procurement philosophy of purchasing products that will "get them through the warranty period." This can be mitigated somewhat by owner-driven approved suppliers lists and strong specifications reinforcing design requirements.

Valves are indeed some of the key "workhorses" in our industrial plants. Just as you would not harness a thoroughbred to a heavy cart or expect a plow horse to win a race around an oval track, you would not install a valve in an application for which it was not well suited. ■

Edited by Gerald Ondrey

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Reducing the Noise from Control Valves

Attenuation for high-noise control valves need not be difficult or expensive

Mark Nord
Emerson

The world does not lack for noise. It pummels us from all sides, emanating from traffic, political commercials, and your annoying neighbor's backyard party. Industrial plants have their share of noise as well, and control valves are a common source. This article explains why control valves make noise, and it shows how these sounds can be abated in a cost-effective manner.

Understanding the problem

Before addressing control-valve noise issues, it is important to understand how noise is created and measured. Sound is measured in decibels (dB), with each one tenth of a bel, a unit of sound intensity named after telephone inventor Alexander Graham Bell. Decibels are not a linear scale, but are logarithmic, which mirrors how the human ear perceives sound. An increase of 3 dB therefore equates to a doubling of sound energy, and a 10 dB increase in sound intensity results in a 10-fold increase in sound energy. Decibel figures for typical sounds are listed below:

- 0 dB – Near complete silence
- 15 dB – Whisper
- 45 dB – Library
- 60 dB – Normal Conversation
- 85 dB – Heavy Traffic
- 90 dB – Noisy Restaurant
- 110 dB – Crying Baby
- 120 dB – Jet Engine / Concert

Humans can generally hear sound frequencies from 20 to 20,000 Hz, but they do not hear all frequencies with equal sensitivity. A human ear perceives an 80 dB sound at 1,000 Hz about as loudly as a 100 dB sound at 100 Hz. Since sound measurements are usually associated with how a human hears them, they are usually measured in a different sound intensity unit called dBA (Figure 1). These measurements are similar to dB measurements, except the energy at the low and high frequencies is weighted less since those sounds are not heard as well by the human auditory system.

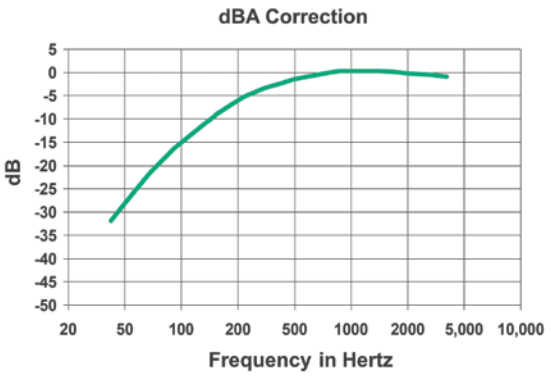

FIGURE 1. Humans hear middle sound frequencies much better than high or low frequencies. The dBA sound intensity scale takes this into account, weighting sound power at very low and very high frequencies lower

Exposure to loud sounds can create permanent hearing loss, with damage dependent on both the sound level and the length of exposure. Sounds greater than 140 dB cause pain and immediate damage, but long-term exposure to constant sounds of more than 85 dBA can also cause damage. If a person must raise his or her voice to talk to someone close by, they are probably in a noise area approaching 85 dBA.

The U.S. Occupational Safety and Health Administration (OSHA) mandates employers implement a hearing conservation program when workers are exposed to >85 dBA for 8 hours or more per day, with that time cut in half for every additional 5 dB of noise exposure.

Sources of industrial noise

Loud sounds in an industrial environment can emanate from a variety of sources, including reciprocating compressors, construction sounds, various machinery and vents. Other common source of noise are control valves, which generate noise in three ways: mechanical vibration of internal components, aerodynamic noise from turbulent gas flow, and hydrodynamic noise from cavitation. Point sources of noise, such as vents, lose energy quickly, while sound energy falls off with the square of the distance (Figure 2).

Control-valve noise is different since the sound radiates from the pipe itself. This creates a linear source of sound that loses energy more slowly than from a point source. Sounds from a valve fall off linearly with distance, so a doubling of the radius only cuts the sound in half.

Another poorly understood phenomenon of industrial noise is its inconsistent additive nature. If two 90 dBA noise sources are near each other, the resulting sound level is 93 dBA (+3 dB is essentially twice the sound energy). However, if a 90 dBA

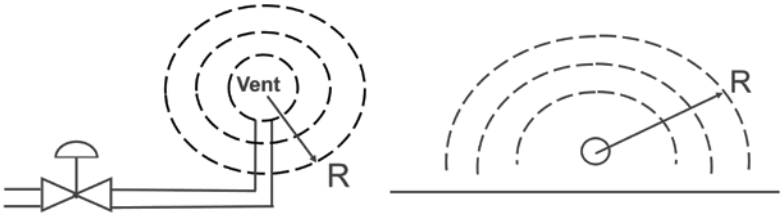

FIGURE 2. Point sources of noise (left) lose four times the energy (6 dB) with each doubling of distance R. Control valve noise (right) radiates sound from the length of pipe, so it only loses half of the sound energy (3 dB) with each doubling of R

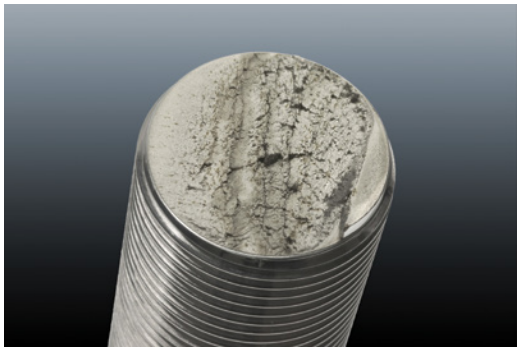

FIGURE 3. High vibrations from control-valve noise above 110 dBA can fatigue and crack control valve stems and shafts

source is near a 70 dBA source, the net sound result is still about 90 dBA, because the louder sound masks the quieter one.

Cutting control valve noise

As mentioned previously, control valves create sound through mechanical vibration of internal components and aerodynamic noise from turbulent gas flow. As gas or steam flows through a control valve, the velocity increases in the narrow passages, creating sound waves that radiate from the valve and piping. Aerodynamic noise varies as the eighth power of the gas velocity, so high flow and high-pressure-drop applications can be exceptionally loud. Obviously, this is a problem for operators in the area, but the associated mechanical vibrations also tend to damage the valve (Figure 3).

Years of application data suggest that damage tends to occur in valves subjected to noise levels greater than 110–115 dBA, so vendors try to avoid control-valve applications with sound levels above that value.

Sound level can generally be abated using either source control (reducing sound at the source) or path control (keeping sound from radiating to the environment). Each method has its advantages and costs.

For control valves, source control is usually accomplished through pressure-drop staging or flow division (Figure 4). Pressure-drop staging reduces the overall sound by dividing a single pressure drop into a number of smaller steps. Smaller pressure drops reduce gas velocity and thus create less noise.

Flow division breaks up a single flow path into multiple ones, reducing flow-stream turbulence and shifting the frequency of the noise spectrum, and subsequently the sound created. These trims are effective at reducing sound, but the complex nature of the internals makes these valves significantly more expensive. They also tend to reduce valve capacity, making it necessary to buy a larger valve.

Path control is another means of sound reduction, and it muffles the sound to keep it from radiating to the environment. Path-control techniques can be as simple as using thick-walled pipe, adding pipe insulation, or encasing the pipe with acoustic blankets or sound-absorbing materials. Alternately, specially designed silencers or modal attenuators (Figure 5) use resonant chambers to cancel the noise through destructive interference.

Any or all of these techniques can be used to suppress the noise and limit operator exposure. It is worth noting that path control does not reduce the sound level, it merely keeps it from reaching the surrounding environment. If the noise level is over 110 dBA, damage to the valve could still occur.

Noise abatement selection

Here are the sequential steps to consider when faced with a noisy control valve application.

1. Protect the valve. Start by protecting the valve itself. If the projected sound levels exceed 110 dBA, long-term damage to the valve is likely. In this case, a source control method will be necessary to reduce the sound level and extend valve life. Noise abatement trims range from relatively inexpensive slotted trims (Figure 4, left) to much more expensive multi-flow path designs (Figure 4, middle). Any of these trims tend to reduce valve capacity, so a larger valve may be required to pass the required flows at an acceptable sound level.

Once the sound level has been reduced below 110 dBA, noise reduction through path control can be considered.

2. Evaluate the noise specification. Many users choose arbitrary noise specifications, with no thought to the economic consequences of their decision. Some require the valve meet a noise specification without using insulation. Others choose an extremely low sound level limit that is virtually impossible to meet. Specifications such as these can drive needlessly expensive valve solutions.

Noise from the surrounding environment should also be considered. If there are already loud compressors or other significant noise sources in the area, the noise from the control valve may not materially change the current sound level.

3. Start with inexpensive and easy solutions. Simply upgrading the pipe wall thickness from standard to XS can reduce sound levels by 2–3 dBA, and the price adder is typically minimal. Properly installed thermal insulation can reduce sound levels by 3 to 5 dBA per inch, to a maximum of 12 to 15 dBA. Properly installed acoustic insulation can reduce sound levels by 8 to 10 dBA per inch up to 24 to 27 dBA total. All these techniques can provide dramatic reductions in sound energy at relatively low cost.

4. Implement more expensive options as required. If the sound level remains too high, other options can be implemented. Diffusers tend to only work well in a limited flow range, so alternatives, such as modal attenuators, can be used to

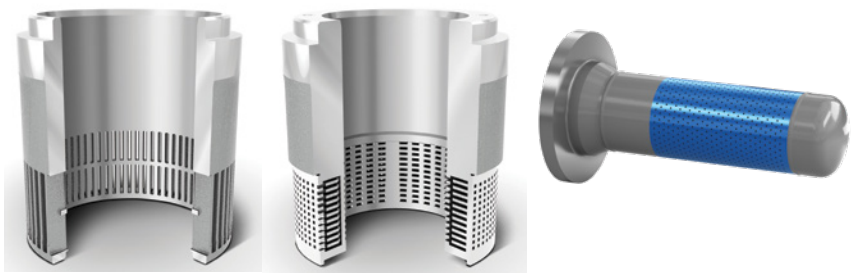

FIGURE 4. Source control uses valve trims with small holes (left), multiple flow paths (middle), or a downstream diffuser (right) to reduce aerodynamic noise

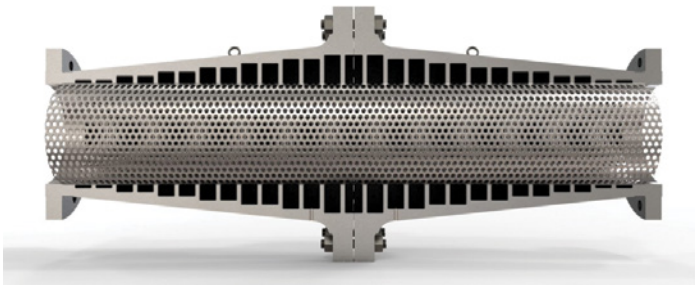

FIGURE 5. This modal attenuator uses varying-sized chambers to generate destructive interference and provide noise reduction across a broad frequency spectrum

provide up to a 15 dBA reduction across a broad frequency spectrum. More advanced noise control trims can also be employed, but increasing reduction in noise generally comes at the price of reduced flow capacity through the valve. It may be necessary to up-size the valve to meet sound specifications, yet still pass the required flowrates.

5. Be careful of claims. Some control-valve low-noise trims do not meet the stated sound reductions. This is often caused by the vendor placing a low-noise trim in a relatively small cavity control valve. A lack of space around the trim keeps it from accomplishing its duty, and the resulting noise reduction can be less than promised.

Example

An end-user specification called for a control valve with the following specifications:

- Inlet pressure – 850 psi
- Outlet pressure – 450 psi
- Temperature – 900°F
- Flow – 150,000 lb/h steam
- Pipe – 6 in., Schedule 160
- Noise specification: <85 dBA with *no* insulation credit

The following are three options to meet the specification, with all dollar figures approximate:

Option 1 is a standard 4-in., #1500 valve with linear trim that generates 103 dBA and costs $34,000. Insulation would reduce the sound to 88 dBA. However, the end user specification disallows insulation, leaving the noise well above 85 dBA.

Option 2 would employ a first-tier noise attenuation trim, which drops the sound level to 87 dBA without insulation. However, this reduces the valve capacity, so the valve must be upsized to 6 in. This raises the cost to $83,000. Note that this solution also fails to meet the uninsulated specification of <85 dBA.

Option 3 would employ a top-tier noise-attenuation trim, which generates 85 dBA with no insulation. This does meet the customer specification, but the reduction in flow capacity forces the valve to be up-sized to 8 in., increasing the cost to $176,000.

It is worth noting that Option 1 should be sufficient in most cases and is just one fifth the cost. This example shows that end users should carefully evaluate the plant specification of <85 dBA (uninsulated) to determine if it is really required, or realistic.

Final remarks

Control-valve noise reduction does not have to be expensive or difficult. However, it does require a solid understanding of the physics involved, and it helps to have a solution partner offering a broad array of noise-reduction solutions. When faced with a noisy control-valve application, it can be helpful to consult with your valve vendor to evaluate the requirements and options because often less costly and viable solutions are available to address the challenges. ■

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All figures courtesy of Emerson.

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Toward the Production of Safer Chemicals

A new protocol for safer chemical design is helping to overcome gaps in 'traditional' toxicology and improve upon federal regulations for endocrine-disrupting chemicals

R. Thomas Zoeller
U. Mass Amherst
Pete Myers
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Research over the past two decades shows clearly that some chemicals manufactured for product functionality can have deleterious effects on human health and the environment at low concentrations. Moreover, many chemicals are transported globally by a variety of mechanisms such that the human population is unavoidably contaminated with biologically active chemicals. An important area of research has been on endocrine-disrupting chemicals (EDCs) — chemicals that exert adverse effects by interfering with the body's hormone systems. These chemicals can have profound effects on fetal and neonatal development, as well as on adult physiology. However, these studies also reveal an approach to create chemicals with the desired functionality while being safer by design.

This article outlines the data informing us about the hazards of manufactured chemicals and discusses ways to create safer chemicals in the future. The article also discusses opportunities created by the proposed European "Chemical Strategy for Sustainability."

Background

The book "Our Stolen Future," published 25 years ago [*1*], examines the ways that certain synthetic chemicals can interfere with hormonal messages involved in the control of growth and development, especially in the fetus. Originally met with skepticism, research efforts since that time leave no doubt that human health is being adversely affected by industrial chemicals, and that the issue is much broader than originally envisioned.

Today, major international medical societies have issued scientific and policy statements warning about the health effects of chronic exposures to EDCs. For example, the Endocrine Society (Washington, D.C.; www.endocrine.org) — a medical and scientific society with over 18,000 members from over 120 countries — has defined an EDC as "…an exogenous chemical, or mixture of chemicals, that interferes with any aspect of hormone action" in Ref. 2. The group has published lengthy scientific statements documenting adverse effects, and is heavily involved in global discussions about the science of endocrine disruption. Furthermore, the Federation of International Gynecology and Obstetrics (FIGO; London, U.K.; www.figo.org) released an opinion, endorsed by many medical organizations, articulating the contribution of EDCs to reproductive harm [*3*]. The World Health Organization (Geneva, Switzerland; www.who.int) has likewise reviewed the literature and determined that EDCs are a global health threat [*4*]. These few examples illustrate the recognition among medical experts that some manufactured chemicals are causing harm to human populations by interfering with hormonal systems, which also has very large economic implications.

The various statements made by these medical and scientific societies are based on thousands of research papers focused on identifying causal relationships between exposure to chemicals or mixtures of chemicals and human health, and the mechanisms that account for adverse effects. Mechanistic studies have shed considerable light on the ways in which manufactured chemicals can interfere with hormone systems.

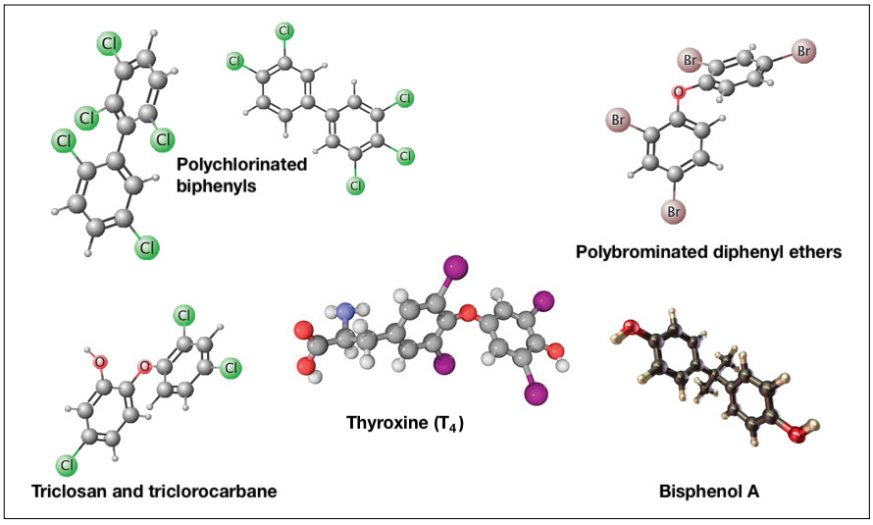

FIGURE 1. Some chemicals manufactured for specific functionalities can have remarkable structural similarities to certain hormone receptors

Key characteristics of EDCs

Chemicals can disrupt hormone systems by interfering at any point along the pathway of hormone action. An important mechanism is by directly interacting with hormone receptors. Hormone receptors mediate all actions of hormones as demonstrated by so-called "knock-out" experiments in mice [*5*], or genetic

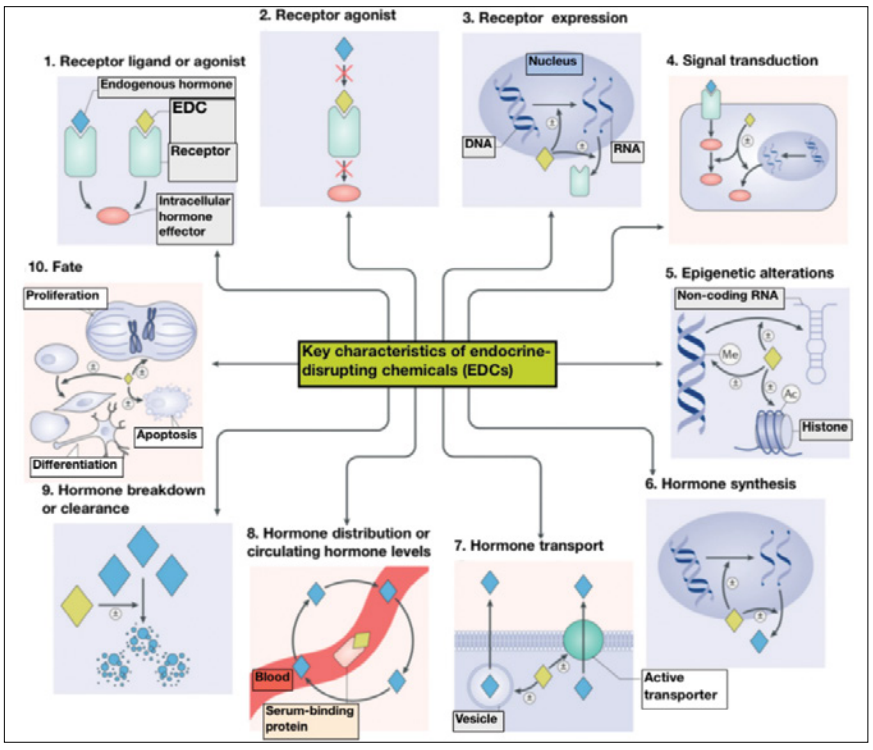

FIGURE 2. Manufactured chemicals have been shown to interact with hormone systems at many levels on the path from hormone production to hormone receptor activation. These are described in detail in Ref. 9. (Reprinted with permission)

defects in humans [*6*], so it is important to recognize that chemicals can interact with these proteins. Examples are industrial chemicals that are structurally similar to thyroid hormone (also known as tetraiodothyronine, thyroxine or T4), which is essential for brain function. A variety of chemicals are known to interact with the thyroid hormone receptor, including polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), triclosan and bisphenol A (BPA). Figure 1 shows the structure for some of these chemicals. Importantly, phase I enzymes that hydroxylate these chemicals can increase their ability to interact with the receptor. Each of these chemicals has been linked to cognitive deficits in children and experimental studies demonstrate that they can interfere with thyroid hormone action. In contrast, many chemicals with structures, sometimes markedly dissimilar to estradiol — the female sex hormone — can interact with the estrogen receptor [*7*].

These examples highlight that commercially available chemicals created for their functionality can interact with proteins that are important for hormonal signaling in very selective ways. In the case of hormone receptors, chemicals can activate or inhibit them. In the case of enzymes that metabolize hormones, chemicals are known to induce their expression [*8*], or alter their activity. These actions have been described as "key characteristics of endocrine-disrupting chemicals," and are illustrated in Figure 2 [*9*]. The work of La Merrill [*9*] highlights the gap between current research and the strategy employed by regulatory systems in the U.S. and globally to protect human health and the environment.

EDC screening program

The Clean Water Act of 1996 mandated that the U.S. Environmental Protection Agency (EPA; Washington, D.C.; www.epa.gov) evaluate chemicals undergoing licensure activities for EDC properties. Their first action was to empanel the Endocrine Disruptor Screening and Testing Advisory Committee that worked from 1996 to 1998 to develop a strategy to test chemicals for EDC properties. The Agency Administrator deemed that the scope of the committee would be restricted to "estrogen, androgen, thyroid and steroidogenesis" (EATS), and the Agency adopted a two-tiered system, the Endocrine Disruptor Screening Program (EDSP), which was outlined in two Federal Register notices published in 1998.

Tier 1 screening data are used to identify substances that interact with the endocrine system — that is, they have an intrinsically hazardous EDC property. In principle, chemicals that go through Tier 1 screening and are found to exhibit the ability to interact with the estrogen, androgen or thyroid hormone systems will proceed to Tier 2 for testing. Tier 2 testing data will identify any adverse endocrine-related effects caused by the substance and establish a quantitative relationship between the dose and that adverse effect. The results of Tier 2 testing will be combined with other hazard information and exposure assessment on a given chemical, resulting in the risk assessment. Risk assessments are used to inform risk-mitigation measures, as necessary, and regulatory decisions concerning chemicals.

Tier 1 of the EDSP includes a battery of tests that include both *in vitro* and *in vivo* assays, totaling 11 in all. Some of the assays included in Tier 1 have not been validated, and none of the Tier 2 assays has been validated [*10*]. In 2011, the EPA issued testing orders for 52 chemicals to be evaluated with the Tier 1 assays, and 18 were determined to need Tier 2 testing in 2015, although test orders were never issued. In 2013, the EPA published a second list of 109 chemicals to be evaluated with Tier 1 assays, but never issued test orders. In 2021, the EPA's office of the Inspector General concluded that, "Without the required testing and an effective system of internal controls, the EPA cannot make measurable progress toward complying with the statutory requirements or safeguarding human health and the environment against risks from endocrine-disrupting chemicals" [*11*].

Regulatory toxicology

Manufactured chemicals that fall under regulatory authorities (for instance, pesticides or food additives) are evaluated for safety using assays that largely have been in use for many decades. They often do not reflect modern biochemical science and are thus insensitive compared to assays used in today's biomedical research (Figure 3). Importantly, the findings from these studies are

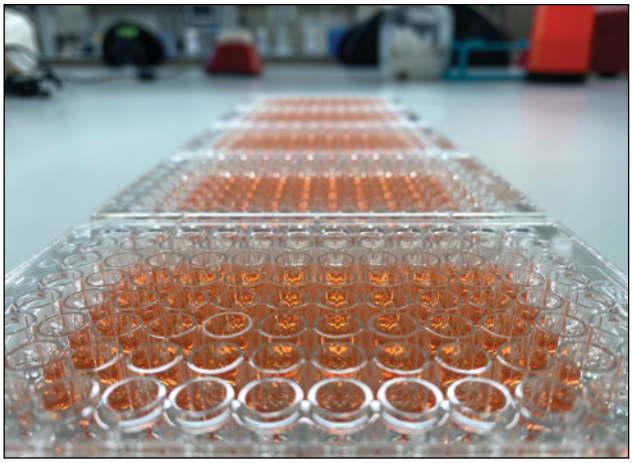

FIGURE 3. The types of assays used in regulatory evaluations often may not reflect advancements in biomedical research, meaning that potential health concerns can be overlooked

generally interpreted from the point of view of "traditional" toxicology. The concept is that the assay endpoint should be reflective of an "adverse effect" and thereby predictive of harm in humans. For example, a chemical that causes a decrease in the number of pups in a rat litter would be considered adverse. Likewise, a chemical that causes a change in the structure or function of the brain would be considered adverse. This requirement for "adversity" almost ensures the use of animal studies because cell-based or biochemical assays (for example, estrogen receptor binding) would not be considered adverse per se using current criteria.

A significant weakness in this paradigm is that EDCs can cause irreversible harm without being identified in one of these regulatory (required) assays [*12*]. For example, thyroid hormone insufficiency (as evidenced by congenital hypothyroidism) in humans results in a variety of adverse effects, such as cognitive deficits, short stature, hypotonia and others [*13*]. Thyroid hormone insufficiency has similar effects in rodents (as well as all vertebrates), including behavioral effects and defects in brain development [*14*]. These effects do not result in a change in brain weight – one of the measures considered adverse in regulatory studies.

Another example is that some chemicals can interfere with the female hormone estrogen in a way that contributes to the acquisition of Type 2 diabetes [*15*]. Again, these effects are not observed by regulatory studies. There are many such examples highlighting that endocrine disruptors cannot be evaluated for safety using traditional approaches and standard interpretations [*16*].

The future of safety assessments

Because of the weakness in test guidelines for EDCs, the E.U. passed two legal frameworks establishing a "hazard-based" exclusion for pesticides (plant protection products and biocides) [*17*]. This means that if a chemical is identified as an EDC, it cannot be licensed within the E.U. with some exceptions for those chemicals with negligible exposures. In contrast, the U.S. has a risk-based approach that focuses on hazard, "potency" and exposure [*10*]. Unfortunately, the gaps

in testing chemical safety in food [*18*] and the environment [*10*] are not likely to be resolved quickly.

However, there are ways to improve chemical and product safety. The U.S. EPA, as well as the Organization of Economic Co-operation and Development (OECD; Paris, France; www.oecd.org), have invested time and funding into "New Approach Methodologies" (NAMs). Essentially, this means non-animal-based approaches, such as *in silico*, *in vitro* and biochemical methods. Despite this effort, it is not clear how this information will be used in regulation, because the convention is that the endpoints acknowledged to be adverse need so-called "apical" endpoints reflective of adverse effects measured *in vivo* [*19*].

There is a movement to complement the concept of a "safe level" of exposure to EDCs to the concept of "safer chemicals." In short, this concept states that chemicals without hormonal activities will be intrinsically safer than chemicals with endocrine activities, at least with respect to endocrine disrupting effects.

A new protocol

In 2012, a multidisciplinary team of scientists proposed a new intellectual framework designed to steer synthetic chemists away from the synthesis and production of another generation of endocrine-disrupting chemicals, the Tiered Protocol For Endocrine Disruption (TiPED). TiPED is conceived as a tool for new chemical design. Thus, it starts with a chemist theoretically at "the drawing board." It consists of five testing tiers ranging from broad *in silico* evaluation up through specific cell- and whole-organism-based assays. To be effective at detecting endocrine disruption, a testing protocol must be able to measure potential hormone-like or hormone-inhibiting effects of chemicals, as well as the many possible interactions and signaling after-effects such chemicals may have with cell-based receptors.

Unlike the EPA's tiered approach using the EDSP, described previously in this article, in which positive results in Tier 1 indicative of likely adverse effects trigger another round of testing in Tier 2, positive results in Tier 1 of TiPED are used to identify new candidate chemicals as likely to be hazardous, and thus not eligible for further development. The exception would be if the chemical's properties justified research that revealed how its molecular structure could be manipulated to eliminate the EDC effect while maintaining the chemical's desirable characteristics. Only if the chemical does not display indications of hazard in Tier 1 is it moved on to Tier 2. The same filter is applied to eliminate candidate chemicals in the remaining Tiers 3 through 5, step by step. Because the early tiers are less expensive and faster, and because they do not involve animals, expensive testing procedures for whole organisms are conducted on only a small fraction of the universe that might be under consideration. This tiered approach of stepwise elimination saves time and resources, and reduces the amount of animal testing overall. The last tier — testing apical endpoints in whole animals — not only protects against known EDC mechanisms, but also reduces the likelihood that currently unknown mechanisms will not be detected by the assays. Because science advances with time and experience, the TiPED system is designed to evolve over time, incorporating the best of today's science, instead of being locked into outdated assays often decades old.

A new strategy for sustainability

On October 14, 2020 the European Commission announced its "Chemical Strategy for Sustainability" as part of the European "Green Deal." Years in the making, sometimes with fraught negotiations, the strategy represents a remarkably forward-thinking agenda based upon modern biomedical science that, if implemented as currently designed, will lead to significant changes in the chemical enterprise. These effects will unfold not just in Europe, but globally, because of the size of the European market and the changes that will be required to achieve the strategy's goals.

A key part of the strategy is adherence to endocrinological science in assessing the hazards of EDCs. This commitment reflects years of educational outreach by the endocrinological community, especially the Endocrine Society and the European Society of Endocrinology, to help E.U. policymakers understand that old, out-of-date approaches championed by traditional toxicologists were inadequate to protect the European public against EDCs. One specific example of the types of changes that may unfold is the case of a very commonly used EDC, bisphenol A (BPA). In December 2021, the European Food Safety Authority recommended that the "tolerable daily intake" (TDI) of BPA be reduced by a factor of 100,000 [*20*]. If this draft recommendation is adopted, it will likely end most if not all uses of BPA in food-packaging materials. With this precedent, the TDIs of other EDC chemicals may also be reduced substantially.

A second key element of the strategy is funding support for chemists seeking sustainable replacements for hazardous chemicals currently in use. This is not simply a matter of taking existing chemicals off the shelf and substituting them with chemicals that have not been evaluated. It will require significant innovation and new chemistry. As the world moves toward a new generation of inherently safer materials, this will advantage the European chemical industry in competition with chemical producers not moving in this direction.

The European Chemical Strategy for Sustainability will lead to large changes in chemical commerce and regulation, and hopefully to significant improvements in the health of Europeans. Competition and innovation to replace hazardous chemicals with sustainable chemicals may lead to similar changes around the world. ■

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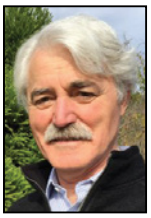

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g. Copies not Distributed (Office, Returns, Spoilage, Unused)	910	535
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i. Percent Paid and/or Requested Circulation	97.90%	97.83%
16. Electronic Copy Distribution		
a. Requested and Paid Electronic Copies	34,693	39,817
b. Total Requested Print and Electronic Copies (Sum 15c and 16a)	61,097	62,852
c. Total Requested Copy Distribution (Sum 15f and 16a)	61,662	63,387
d. Percentage Paid and/or Requested Circultion (Both)	99.08%	99.16%

17. Publication of Statement of Ownership for a Requester Publication is required and will be printed in the November 2022 issue of this publication
18. Signature of Fulfillment Manager: George Severine Date: 9/30/22

PS Form 3526-R, July 2014

CHEMICAL ENGINEERING
ESSENTIALS FOR THE CPI PROFESSIONAL
Access Intelligence

Valves

special advertising section

Inside

Valve Manufacturing Done Right

Inline Industries, a California corporation, manufactures industrial valve products for the U.S. and international marketplace. Inline specializes in the production of high performance, corrosion resistant ball valves and automated systems. Inline delivers exceptional value to customers by providing the three most important elements they look for in a manufacturer: quality, availability, and price.

Inline's business model is designed to provide quality products and unparalleled customer service to the chemical process industry. Whether it is providing valves to skid builders (O.E.M. accounts) EPC firms or end users, you can rest assured Inline valves are designed and made to ASME and API standards. Inline also carries many different quality certifications.

Inline's staff provides real-time factory support to address technical questions. Inline offers sole source automated systems with pneumatic or electric actuators, solenoids, limit switches, and positioners. Product can usually ship within a couple of days. Additionally, Inline is able to modify existing products or manufacture new designs to meet your specific O.E.M. requirements.

By providing a broad range of high-quality products at competitive prices, Inline offers customers a significant advantage in today's marketplace.

www.ballvalve.com

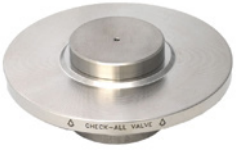
Proven Zero Leakage Control Valves for Liquid and Gas.

Kepner's proven Flexible Seal Seat™ design offers positive shutoff of liquid or gas as confirmed by helium leak testing. The seat design is a carefully engineered combination of metal-to-metal and resilient O-ring seal contact. The O-ring is securely retained at the seat rather than on the poppet, protecting it from the destructive abrading and blasting effect of the flow. The result is a design that holds up to extended harsh cycling where competing "soft seat" valves wear and fail.

Kepner Products Company's Flexible Seal Seat™ valves are available in both inline and cartridge insert styles, providing check, relief, shuttle and pilot operated check functions. An extensive selection of port options, materials and flow ranges up to 500 GPM provide over 100,000 product configurations that cover a wide range of pressures, temperatures and media types. Kepner also provides value-added services, custom designs and special testing to meet specific requirements. For more details visit our website.

Kepner Products Company, Villa Park, IL **www.kepner.com**

More than a Check Valve…It's a Check-All!



Check-All Valve Mfg. Co. makes a complete line of in-line spring-loaded poppet style check valves. Many series are available which provide check valves for practically every service application. Valves are offered with metal-to-metal or soft seats in sizes ranging from 1/8 inch NPT to 20 inch flange connections. Pressure ratings are available from full vacuum to 10,000 PSI. Standard or exotic materials are available and you can choose from a wide variety of spring settings for any valve. Most options are available with fast delivery and online ordering is available. CE/PED Compliant, CRN Registered, NACE, ISO 9001 Certified. Call or email for a catalog. Please visit us at: sales@checkall.com, or call us at: 515-224-2301. Order online at: **www.checkall.com**

Plastic Control Valves Handle Corrosive Chemicals

Collins 2-in. valves and actuators are specially designed to handle corrosive fluids – acids, bleaches, chlorine, pH control – and aggressive environments

Collins Instrument Company's line of economical 2-in. flanged plastic control valves handle corrosive liquids including hydrochloric acid, caustic, sulfuric acid, and many others. With bodies of either PVDF or polypropylene, these highly-responsive control valves are specifically designed for use with corrosive media and/or corrosive atmospheres.

Suitable for applications in numerous industries, including chemical, petrochemical, pulp and paper, and municipal, these valves are extremely corrosion-resistant, and feature fast-acting positioning (stroke rate approximately ½ in./s). They are available with a wide selection of trim sizes, in globe, angle, and corner configurations.

The differential-area piston eliminates the necessity for auxiliary loading regulators. All actuator parts apart from the integral positioner are molded of glass-filled, UV-inhibited polypropylene. Before shipment, the aluminum positioner and a portion of the cylinder are immersed in Dip Seal to provide atmospheric protection.

Plastic valves and actuators from Collins

The integral positioner eliminates the need for external linkages which are subject to corrosion and malfunctioning. Valves may also be furnished without a positioner for on/off applications.

Collins also offers a plastic pneumatic actuator. The combination of a plastic actuator and a plastic valve body provides an effective way to handle both corrosive materials flowing through the valve, and harsh environments that can attack the outside of the valve and actuator. Collins plastic control valve packages withstand salty marine atmospheres as well as industrial environments that are too corrosive for metal valves and actuators.

Collins actuators incorporate a unique internal locking ring to attach the cylinder to the yoke. A semicircular groove is machined inside the lower edge of the cylinder, and a matching groove cut in the yoke. When the yoke and cylinder are assembled, a flexible polypropylene rod is inserted into the groove through a slot in the side of the cylinder, securing the two sections together.

Along with its corrosion resistance the Collins control valve features a stem packing arrangement that virtually eliminates the problem of fugitive emissions, thereby protecting the environment.

Located on the Texas Gulf Coast in the town of Angleton, Collins Instrument Company has been serving the chemical and petrochemical industry for over 65 years. **www.collinsinst.com**

Electric actuators for Profinet

AUMA's PROFOX actuators with Profinet ensure future-proof plant automation

AUMA's small and smart PROFOX actuators can now be integrated into Profinet networks.

AUMA's PROFOX electric actuators are now available with Profinet communication, making them a perfect choice for high-precision valve control within Profinet networks. With their innovative diagnostics and enhanced connectivity, PROFOX actuators ensure future-proof plant automation.

PROFOX actuators provide reliable, high-performance valve automation for process applications of all kinds. They also gather a multitude of diagnostic and device data that can be easily used by the DCS or higher-level systems, thanks to Profinet communication, enabling plant operators to benefit from increased efficiency and optimised process control.

PROFOX actuators offer direct Profinet integration, without the need for gateways. MRP media redundancy is available as standard, and S2 system redundancy as an option. An integrated web server for testing and diagnostics as well as a field device integration (FDI) package facilitate commissioning.

With the PROFOX platform including multi-turn, part-turn and linear actuators AUMA offers versatile valve actuation solutions for the lower torque ranges. The compact PROFOX actuators are ideal for tight spaces such as skid installations. Motor speed is adjustable, ensuring fast and precise valve control. Operating costs are low, thanks to high mechanical efficiency and low standby consumption.

PROFOX actuators are simple and easy to use, with rapid installation and commissioning via an intuitive app. High-quality design and construction ensure long life even under the toughest process conditions.

www.profox.auma.com

Stainless Steel Butterfly Valve

The **Posi-flate** butterfly valve with a highly polished 316 stainless steel housing and disc is suitable for many applications, such as food, chemical and pharmaceutical. The inflatable seat design of the Posi-flate butterfly valve provides a better seal by utilizing air pressure to expand the seat against the disc, providing more sealing area and an even pressure distribution against the disc every time. The seat automatically compensates for wear when it inflates against the disc, extending valve life considerably. Because the Posi-flate disc only makes casual contact with the seat during opening and closing, torque requirements are substantially lower. This ease of movement also allows the disc to come to a perfect 90-degree position every time. Additionally, the smooth profile of the disc helps material flow easier and reduces build-up. The Posi-flate stainless steel butterfly valve is available in sizes of 2" (50mm) to 20" (500mm).

Stainless Steel Posi-flate Butterfly Valves

www.posiflate.com

Economic Indicators

2020 2021 2022

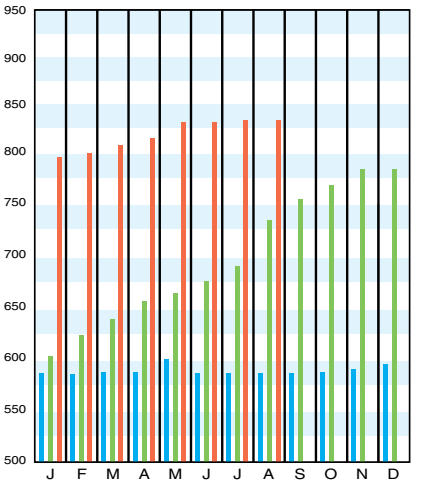
Download the CEPCI two weeks sooner at www.chemengonline.com/pci

CHEMICAL ENGINEERING PLANT COST INDEX (CEPCI)

(1957–59 = 100)	Aug. '22 Prelim.	Jul. '22 Final	Aug. '21 Final
CE Index	824.5	829.8	735.2
Equipment	1046.2	1054.5	918.6
Heat exchangers & tanks	879.3	891.0	784.8
Process machinery	1054.4	1073.9	921.1
Pipe, valves & fittings	1480.8	1480.2	1304.7
Process instruments	556.5	558.8	541.3
Pumps & compressors	1305.3	1304.4	1148.8
Electrical equipment	774.0	770.0	616.8
Structural supports & misc.	1183.2	1199.5	1000.4
Construction labor	359.7	357.1	347.4
Buildings	826.6	834.2	767.5
Engineering & supervision	312.1	312.0	310.2

Annual Index:
2013 = 567.3
2014 = 576.1
2015 = 556.8
2016 = 541.7
2017 = 567.5
2018 = 603.1
2019 = 607.5
2020 = 596.2

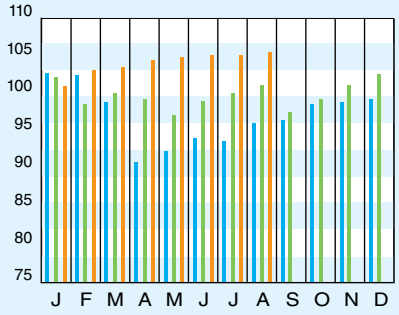
Starting in April 2007, several data series for labor and compressors were converted to accommodate series IDs discontinued by the U.S. Bureau of Labor Statistics (BLS). Starting in March 2018, the data series for chemical industry special machinery was replaced because the series was discontinued by BLS (see *Chem. Eng.*, April 2018, p. 76–77.)



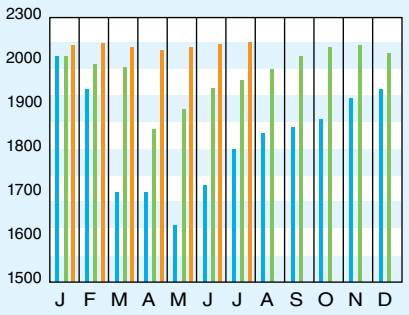
CURRENT BUSINESS INDICATORS

	LATEST		PREVIOUS		YEAR AGO	
CPI output index (2017 = 100)	Aug. '22 = 102.5		Jul. '22 = 102.1		Jun. '22 = 101.6	Jul. '21 = 99.3
CPI value of output, $ billions	Jul. '22 = 2,171.9		Jun. '22 = 2,239.1		May '22 = 2,194.5	Jun. '21 = 1,814.7
CPI operating rate, %	Aug. '22 = 82.9		Jul. '22 = 82.6		Jun. '22 = 82.3	Jul. '21 = 80.6
Producer prices, industrial chemicals (1982 = 100)	Aug. '22 = 364.8		Jul. '22 = 387.5		Jun. '22 = 379.0	Jul. '21 = 331.7
Industrial Production in Manufacturing (2017 =100)*	Aug. '22 = 102.2		Jul. '22 = 102.1		Jun. '22 = 101.5	Jul. '21 = 98.9
Hourly earnings index, chemical & allied products (1992 = 100)	Aug. '22 = 199.4		Jul. '22 = 199.6		Jun. '22 = 197.8	Jul. '21 = 193.6
Productivity index, chemicals & allied products (1992 = 100)	Aug. '22 = 94.4		Jul. '22 = 93.8		Jun. '22 = 93.2	Jul. '21 = 95.2

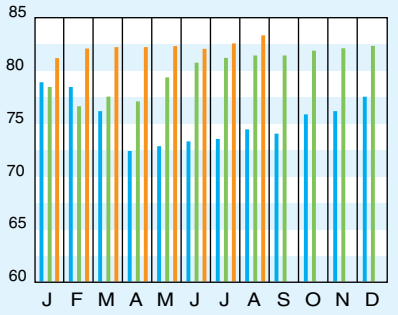
CPI OUTPUT INDEX (2017 = 100)†



CPI OUTPUT VALUE ($ BILLIONS)



CPI OPERATING RATE (%)



*Due to discontinuance, the Index of Industrial Activity has been replaced by the Industrial Production in Manufacturing index from the U.S. Federal Reserve Board.
†For the current month's CPI output index values, the base year was changed from 2012 to 2017
Current business indicators provided by Global Insight, Inc., Lexington, Mass.

CURRENT TRENDS

The preliminary value for the *CE* Plant Cost Index (CEPCI; top) for August 2022 (most recent available) declined from the previous month — the second straight monthly decline after a long string of increases between November 2020 and June 2022. For August, the Equipment and Buildings subindices decreased, offsetting small increases in the Construction Labor and Engineering & Supervision subindices. The current CEPCI value now sits at 12.1% higher than the corresponding value from one year ago. Meanwhile, the Current Business Indicators (middle) show small increases in the CPI output index and the CPI operating rate for August 2022, and a decrease in the CPI value of output for July 2022.